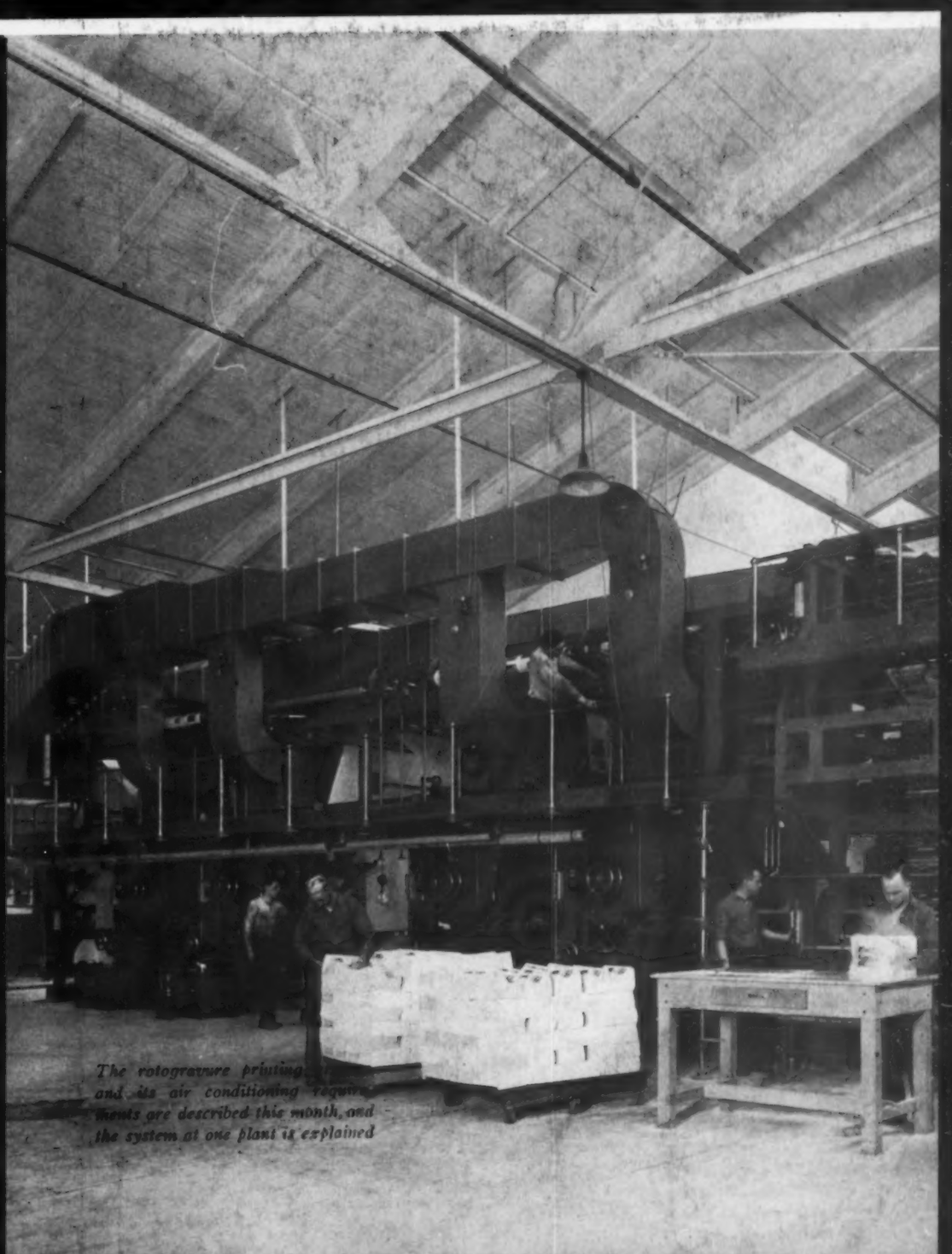
AUG 9

Heating · Piping and Air Conditioning



The rotogravure printing and its air conditioning requirements are described this month, and the system at one plant is explained

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THE PANCAKE COIL has received an enthusiastic welcome and for good reasons. It is copper tube in a new and more convenient form . . . easier, more economical to pack, ship, store and handle. But just as important are its bright and shining uniformity, its complete freedom from dents, defects, or the slightest imperfections. It comes to you just as it comes out of the very modern annealing furnace shown here. Thorough cleaning and careful inspection guarantee flawless top quality in every inch. Have you discovered the advantages of the Pancake Coil? It is a typical Bridgeport contribution to your progress and profit.

"Bridgeport"

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The Editor's Page

■ **Health and air conditioning** is the theme of the current issue of "Air Conditioning Trends," issued by the Keeney Publishing Co., publisher of HEATING, PIPING AND AIR CONDITIONING. Among its features are an interview with Dr. W. J. McConnell, assistant medical director of the Metropolitan Life Insurance Co., on the studies the company has made in their air conditioned office building; a story on the health benefits of air conditioning reported by the Philadelphia Electric Co.; an interview with Dr. C. A. Mills, who has done a great deal of work on the effect of climate and believes a better understanding of this effect is needed to study the health value of air conditioning. . . . One of the first attempts on the part of a department store to evaluate the benefits of air conditioning upon the health and efficiency of its employees is being undertaken by R. H. Macy & Co., New York City, "Trends" announces. . . . Copies of "Trends" are available by request on business letterhead. . . . In the first report of the committee established by the American Medical Association to study air conditioning (entitled "Physical and Physiologic Principles of Air Conditioning," by C. P. Yaglou) the basic physical and physiologic principles involved are evaluated and it is pointed out where data are inadequate and where research is urgently needed. The report, which has been published in the Journal of the Association, discusses in detail the need for air conditioning, the bases of comfort, and gives references to 55 papers and reports on the subject.

■ **Installed cost** of equipment sold by members of the Air Conditioning Manufacturers' Association in the first five months of 1937 exceeded the total for all 1936, being $50,131,360 as compared to $49,942,301 last year, William B. Henderson, executive vice-president, announced recently. . . . Every month reported this year has broken all records of previous years. . . . Air conditioning installations in Chicago during the first six months this year established a new high record, the Commonwealth Edison Co. reports, the number of jobs totaling 341 compared with 245 in the corresponding period last year, an increase of 39 per cent. The 1937 jobs aggregate 9742 hp compared with 5,810 hp the first six months of 1936, an increase of 68 per cent.

■ **Air conditioning of hotels** will reach new heights this year, with cities in widely separated sections in the United States reporting unprecedented improvement programs, according to William B. Henderson, executive vice president of the Air Conditioning Manufacturers' Association. . . . 1,000 of the 16,000 U. S. hotels already are air conditioned throughout, or in part, he says. . . . Even when air conditioning of an entire hotel is deferred, the ease with which part of the structure can be air conditioned quickly creates improved service and comfort for the guest, Mr. Henderson points out. An Omaha hotel conditioned its first floor of guest rooms, thereby increasing their rentability by making it possible to keep windows closed to exclude street noises. The air conditioning of the top floor of an Alabama hotel converted undesirable rooms under the roof to the most popular. . . . According to the Carrier Corp., following air conditioning and interior renovation of some of the public rooms of a Syracuse hotel the food and beverage business increased 200 per cent. . . . The Mayfair and Lennox hotels in St. Louis, which have recently been air conditioned at a cost of $200,000, have been making some studies on the importance of conditioned hotel accommodations for salesmen. Here is what they found from a questionnaire sent to sales managers of a number of large firms. . . . 85 per cent felt that salesmen's efficiency was increased by a night spent in an air conditioned room. . . . 64 per cent believed that if air conditioned rooms were available in warm cities, salesmen would do a better job, would be less likely to hurry out of town without making adequate calls. . . . 63 per cent believed that sales were increased when salesmen had air conditioned hotel facilities in which to entertain clients. . . . 45 per cent of the firms questioned said their salesmen were urged to take advantage of air conditioned hotel rooms when available. . . . For further information on the advantages of hotel air conditioning see the February issue of "Air Conditioning Trends," issued by the publisher of HEATING, PIPING AND AIR CONDITIONING.

■ **Atmospheric Pollution**—The air conditioning units used in some office buildings reduce the concentration of sulphur dioxide in them to less than 40 per cent of what it is without the units in operation, it was found in an investigation of atmospheric pollution in Chicago reported recently by Frank A. Chambers, A. D. Singh, and I. A. Deutch. On the 12th floor of a Loop office building 0.14 p.p.m. of SO_2 was found. With an air conditioner on for 15 minutes before starting the test, the concentration dropped to 0.06 p.p.m.

■ **New Plant**—The former Franklin plant, of a million and a quarter square feet, taken over recently for taxes by the City of Syracuse, was bid in at public auction last month for Carrier Corp. It is expected that 80 per cent of the administrative and productive operations of the air conditioning company will be shifted to Syracuse within one year.

■ **In a survey** conducted by Nash-Kelvinator Corp. in which business men were asked to put a dollar-and-cents value on the comfort and health values received through the air conditioning of their homes and offices, it has been estimated that air conditioning is worth more than it costs by at least 1000 per cent. According to J. K. Knighton, who supervised the study, the estimates were several times higher than industry experts had expected . . . According to a report on air conditioning and respiratory affections by Prof. F. H. Hodgson of the Roosevelt Hospital, New York City, victims of hay fever and other respiratory ills "are assured of a high degree of benefit from air conditioning." . . . In a test conducted in a pollen impregnated room, 7 hours of using a portable air conditioner resulted in a reduction in 99 per cent of the pollen and 98 per cent of visible dust. Copies of the report have been made available by the Carrier Corp.

■ **Dedicated to the story** of electric power in the "world of tomorrow" will be General Electric's building at the New York World's Fair in 1939 . . . A contract for some 68,000 sq ft of exhibit space was recently signed by G. E. . . . General Electric has announced an extensive educational program in air conditioning designed to attract young men into the industry. . . . The program, to be sponsored by the company itself, is to be worked out through its distributors in the field and will be open primarily to graduates of colleges, technical schools and high schools who want to establish themselves in the industry.

31 Major Industries

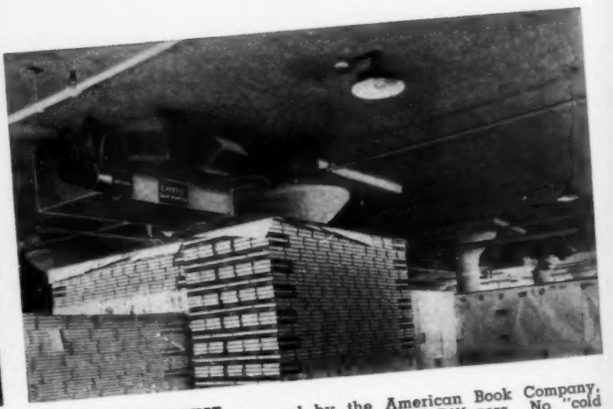
CUT HEATING COSTS

with

Carrier Unit Heating

Also Report Space Saved . . . Efficiency and Comfort of Workers Increased

TYPICAL FACTORY installation is this—in the Summerill Tubing Company, Bridgeport, Pa. By replacing heating coils with Kroy Unit Heaters, steam consumption was greatly reduced. "And," writes Gen. Mgr. Lawson, "our men . . . were comfortable on the coldest days."



HERE'S A WAREHOUSE—owned by the American Book Company, Cincinnati, showing the use of Carrier Heat Diffusers. No "cold spots" here—the temperature is uniformly comfortable. And it's automatic—thanks to the Thermajust control.

RETAIL STORES, like the American chain in Philadelphia find Carrier Kroy Units ideal—they require no attention—occupy no sales space—keep the temperature exactly right—and are handsomely-designed to harmonize with store decorations.

PLAY SAFE!

Specify Carrier Unit Heaters

● Thousands of Carrier Unit Heaters installed 10, 12, even 15 years ago, are still on the job—operating as efficiently and as economically as the day they were made. And here's the reason: Carrier Construction. For example, every Carrier Unit Heater, regardless of size or style, employs the return bend coil construction which eliminates strains due to expansion and contraction, and makes leaking virtually impossible. Every Carrier coil is non-ferrous, cannot rust—and all connections are brazed—never screwed. The Carrier coil is specifically a heating coil—not a modified auto radiator.

Look farther and you'll find many other reasons why Carrier Unit Heaters are giving trouble-free service in thousands of the world's industries. Fans, for example, designed to reduce required horsepower as much as 50%. Assemblies so balanced that vibration and noise are reduced to the smallest practical value. Countless small details that keep repair and replacement costs down. You can depend on Carrier Unit Heaters.

Get the complete facts about Carrier Unit Heaters today—the sizes and styles available. And take advantage too, of Carrier's heating experience in 99 countries of the world, in structures of every conceivable size and shape, to solve your heating problems. There's no obligation, of course.

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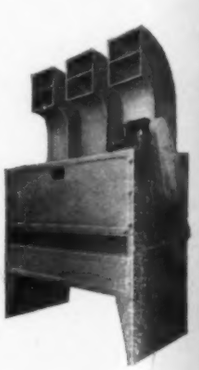
CLOSE-UP of the Kroy Unit, styled for appearance as well as utility. Coils are non-ferrous, and so constructed that strains due to expansion and contraction are eliminated. Guaranteed to withstand operating pressures of 200 lbs. per sq. in.



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Design, Installation
Operation, Maintenance
in Industry and Large Buildings

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Published monthly by the Keeney Publishing Company, 6 N. Michigan Ave., Chicago. Telephone: State 6916/ F. P. Keeney, President; W. J. Osborn, Vice-President; R. Payne Wettstein, Secretary; Chas. E. Price, Treasurer/ Address all correspondence to Chicago office/ New York office, Room 1950, Grand Central Terminal Bldg. Telephone: Murray Hill 2-8293/ Cleveland office, 2128 Rossmoor Road. Telephone: Yellowstone 1540/ Los Angeles office, 1406 S. Grand Ave. Telephone: Richmond 6191/ Subscriptions: U. S. and possessions, Canada, Mexico, Central America, South America, $2.00 per year; other, $4.00. Current copies, U. S. and possessions, 25c each, back copies 50c each. January, 1937, issue, $1.00 per copy/ Member of Audit Bureau of Circulations/ Member of The Associated Business Papers, Inc./

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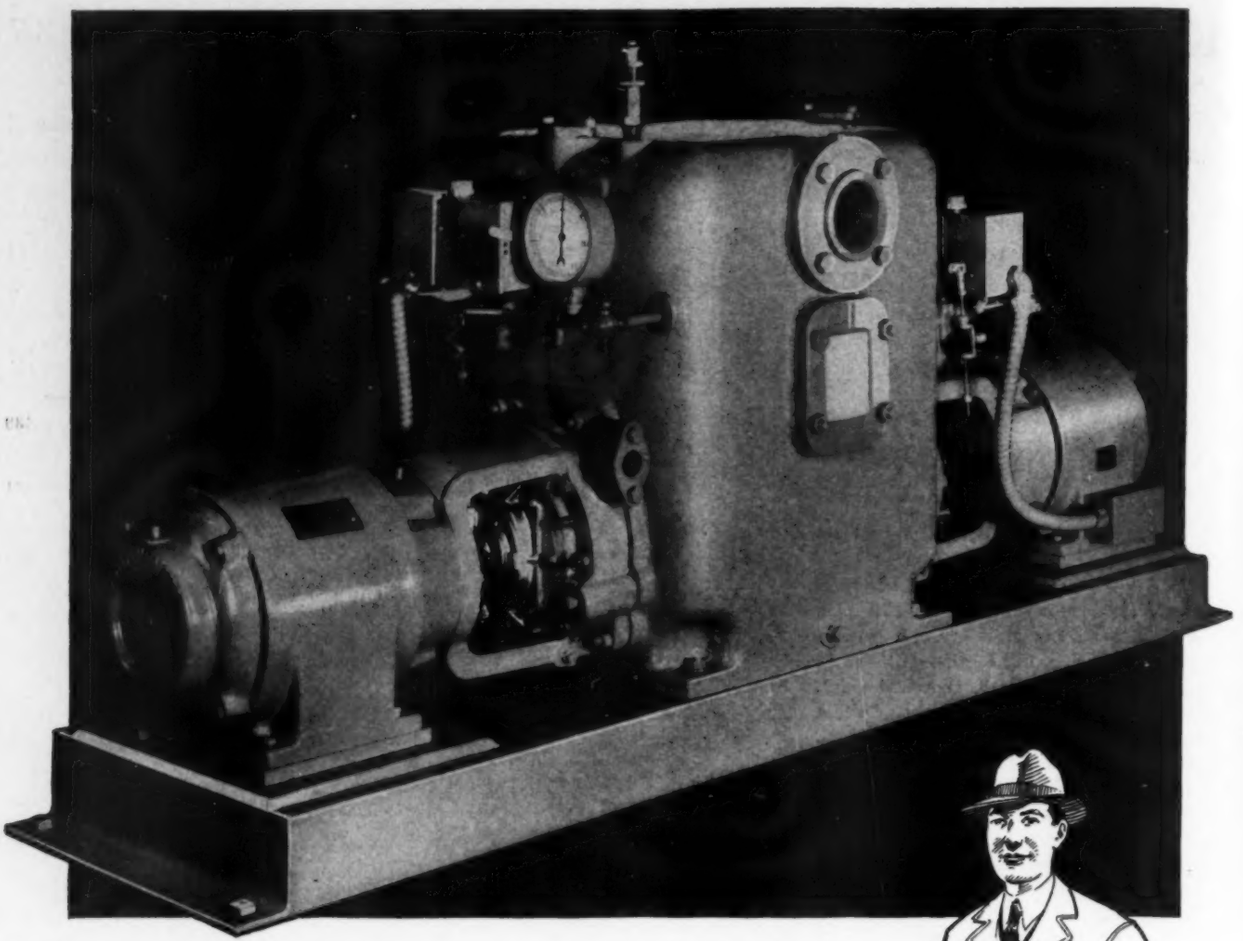

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SOUTH NORWALK, CONNECTICUT, U. S. A.

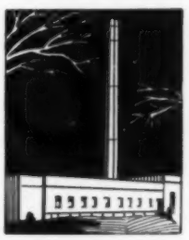
Heating·Piping
and Air Conditioning

Vol. 9, No. 8 ● *August, 1937*

An Accurate Method for

Control of Heating Fuel Costs

WHEN the coal bill or steam bill is received it must be inspected to decide whether or not the current consumption of these commodities is satisfactory. Since most of the bill represents consumption for heating purposes, which varies from month to month, it is difficult to find the standard with which the consumption for the various periods may be compared. The degree day has been used to define this standard in many different ways, but the most obvious employment of the degree day for this purpose has been overlooked and little used. This is the simple correlation of consumption against degree days for a unit period.



It should be of interest, therefore, to describe this method with the hope that engineers will find it useful for determining "how much is enough" fuel consumption. The author, who is interested in the problem as a practical application of statistical method, has been fortunate in having access to records of steam consumption for an institutional building group. Since these figures are in terms of pounds of steam consumed monthly the method is illustrated in those terms, but obviously other units of consumption—pounds of coal, gallons of oil, cubic feet of gas—and other unit periods (a weekly period has been successfully applied in one group of buildings) would serve equally well.

The "Normal" Consumption Curve

If steam use is plotted against degree days by months (or any unit period) the relationship between the two will be most obvious (Fig. 1). This relationship can be described by an average or "normal" curve, representing steam consumption as a function of degree days.

In order that the curve may be drawn with the proper shape and slope it is best to plot the data of more than one season, so that a large number of observations may be used in determining the curve. The various seasons are kept separate by the use of different symbols or different colored inks. In most cases the curve will not be a straight line. Figs. 1, 2 and 3 illustrate the types of curves which may be found.

"Normal" curves were fitted to the data for 68 buildings of the building group for which records were available. It was found that a curve would describe the relationship of consumption to degree days satisfactorily for the range of 150 to 1400 degree days per month only. For the locality under consideration, no ordinary month will have more than 1400 degree days. In months with less than 150 degree days only a small amount of steam is used for heating, and that so irregularly that it cannot be related to degree days.

The curves can be sketched in freehand with sufficient accuracy for practical purposes. Each curve is located at a level to correspond with the data for the most recent year, unless it is known that this season is not as representative of the future as some of the others. In fitting the curves, the *median* rather than the *mean* is used—that is, the curves are drawn so that approximately one-half the observations lie on either side. This is suggested because it is easier than averaging out the deviations, and is more reliable, since extreme deviations due to unusual conditions do not affect the curve.

If the "normal" consumption is read off the curve at two or three points—say 500 and 1000 degree days per month—and divided by the cubage of the building, comparison of the curves for different buildings can be made and peculiarities of consumption per unit of cubage detected. Erring buildings can then be investigated and an attempt made to bring them into line.

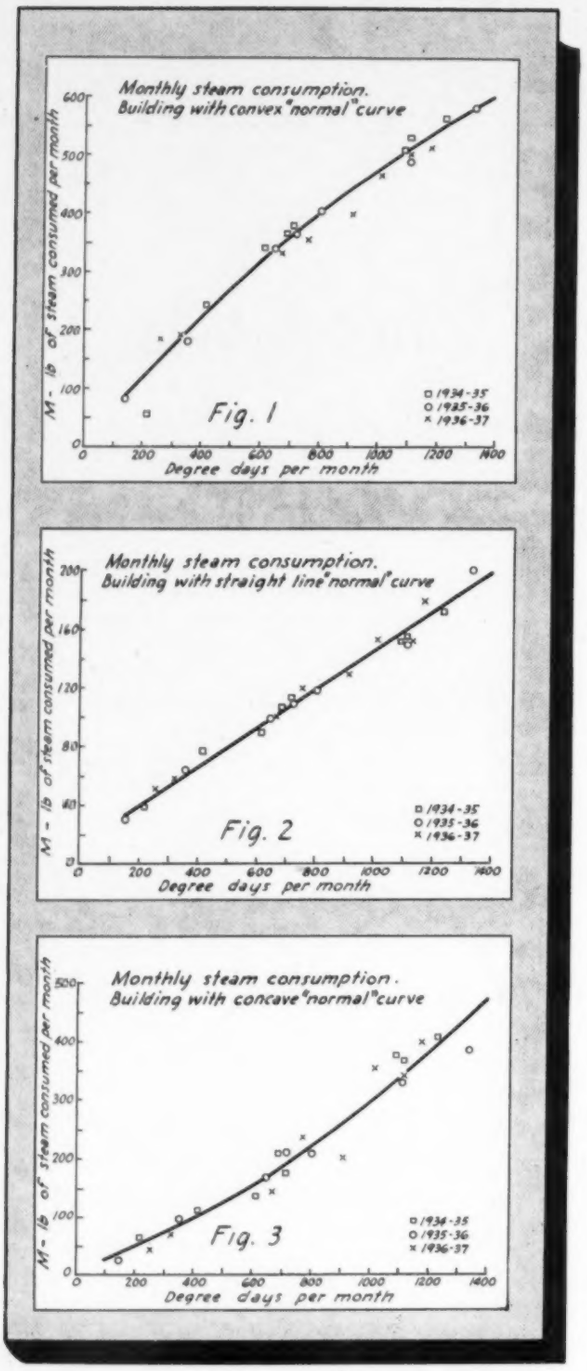
The "normal" curves by themselves are a useful check on heating consumption. If the consumption for the current month is plotted on the chart it is comparatively easy to judge whether or not it is satisfactory by comparing former deviations from the "normal" curve with the current deviation.

However, if the relationship between the current deviation and past deviations can be expressed numerically,

By W. S. Bard*

The author recently became interested in the application of statistical methods to the comparison of steam consumption for heating buildings month by month, in order that tendencies toward waste might be detected. . . . His scheme is described here in manual form with the hope that engineers will find it a simple, flexible, easily applied procedure to determine how much is enough fuel or steam to heat a building, taking into account the variables involved

*Mr. Bard is a graduate of the School of Business of the University of Chicago. He is indebted to the members of the Department of Buildings and Grounds of that institution, who have allowed him free access to their records of steam consumption. This article is an abstract of his report on his studies.



the comparison will be less subjective and therefore more accurate. This is important when it is necessary to compare performance in several buildings. It may be accomplished if the quartile deviation or semi-interquartile range of the deviations from the "normal" curves is computed for each building.[1]

The Quartile Deviation

To compute this measure of variation the yearly series of deviations of actual consumption from the "normal" are read off the chart (the use of a rule is convenient for this) and set down in a table. The distance between the first and third quartiles is determined and divided by two. To take an illustrative series of deviations:

Deviations	Quartiles	Interquartile Range	Semi-Interquartile Range
+145			
+ 80			
	3rd +60		
+ 40			
+ 35			
	2nd or median	140	140/2 or 70
— 40			
— 55			
	1st —80		
—105			
—120			

The size of the quartile deviation is roughly related to the size of the building, but is influenced by other factors, such as the degree of variation in the amount of steam used for purposes other than heating, the type of temperature control in the building, etc. It may be found that the size of the quartile deviation will vary from year to year. The most recent may be regarded as the most appropriate. If this is large as compared with cubage, an effort should be made to decrease it by watching the building more closely and adjusting steam use to the outside temperature. The proper size of the ratio of the quartile deviation to the cubage of the building must be determined by comparing similar buildings.

The Deviation Ratio

One step remains to reduce the data to a form permitting month-to-month and building-to-building comparisons of performance. The actual deviation each month is divided by the quartile deviation for the building, to give the deviation ratio.

The "normal" curve, by its shape and slope, and the quartile deviation, by its size, adjusts for the peculiarities of each building, so that building-to-building comparisons of the deviation ratios are valid. Further, the curves considered herein and the deviations therefrom have shown that the average size of the deviations in the various ranges of degree days tends to be the same—that is, the size of the deviations of actual consumption from "normal" tends neither to increase nor to decrease with increasing amounts of steam consumed. Hence it is preferable to express the allowable deviation as some multiple of the quartile deviation rather than as a percentage of the normal represented by the curve. For this reason month-to-month comparisons of the deviation ratios are valid.

The Monthly Report

When several buildings are under the jurisdiction of one person, as in an institutional group, it is convenient to compare their performance in tabular form. For this purpose a monthly report form has been devised (Fig. 4).

The first section is a table comparing the deviation ratios for each group of buildings, arranged by master meters. The "normal" consumption is read off the charts as soon as the number of degree days for the month is known. Then, when the meters have been read, the actual consumption in each building is set down. The deviations are computed and divided by the quartile deviation for each building. It is then possible to note the ratio for (1) the entire group, (2) the master meters, and (3) the individual building meters. It is easy to trace out the buildings responsible for either

[1] "Quartile" designates a point so chosen that ¾ of the individuals in a series are on one side of it and ¼ on the other.

Steam Consumption Control Sheet

For period from March 26, 1937 to April 26, 1937

Degree Days:

This Month 671

Normal 602

Meter No.	Name of Building	Steam Consumption in M-lb			Quartile Deviation	Deviation Ratio	
		Actual	Normal	Over or Under Normal		Building Meters	Master Meters
1	Total Steam	39588	38400	+1188	1000	.....	+ 1.2
5	A	4443	3925	+ 518	225	.....	+ 2.3
93	B	149	160	— 11	11	— 1.0	.....
103	C	369	362	+ 7	18	+ 0.4	.....
106	D	926	832	+ 94	59	+ 1.6	.....
107	E	558	480	+ 78	23	+ 3.4	.....
110	F	676	540	+ 136	68	+ 2.0	.....
117	G	490	430	+ 60	22	+ 2.8	.....
119	H	135	110	+ 25	21	+ 1.2	.....

Summary

Distribution of Ratios This Month

Size of Ratio	Number of Buildings							Percentage of Total
	Meter 5	Meter 6	Meter 8	Meter 7 & 9	Meter 3	Group 4	Total	
Over + 6	.....	.....	.....	.....	.....	.....	0	0
+ 5 to + 5.99	.....	.....	.....	.....	.....	1	1	1.5
+ 4 to + 4.99	.....	.....	.....	1	.....	.....	1	1.5
+ 3 to + 3.99	1	.....	.....	.....	.....	.....	1	1.5
+ 2 to + 2.99	2	.....	.....	.....	2	.....	4	5.8
+ 1 to + 1.99	2	3	2	1	.....	1	9	13.2
0 to + 0.99	1	5	1	2	.....	2	11	16.2
0 to — 0.99	.....	7	1	3	3	1	15	22.0
— 1 to — 1.99	1	8	1	7	.....	1	18	26.5
— 2 to — 2.99	.....	3	.....	1	.....	.....	4	5.8
— 3 to — 3.99	.....	1	.....	.....	.....	.....	1	1.5
— 4 to — 4.99	.....	.....	1	.....	.....	.....	1	1.5
— 5 to — 5.99	.....	.....	1	.....	.....	.....	1	1.5
Under — 6	.....	.....	.....	1	.....	.....	1	1.5

Median of All Ratios—0.46

Recapitulation

1936-1937 Season

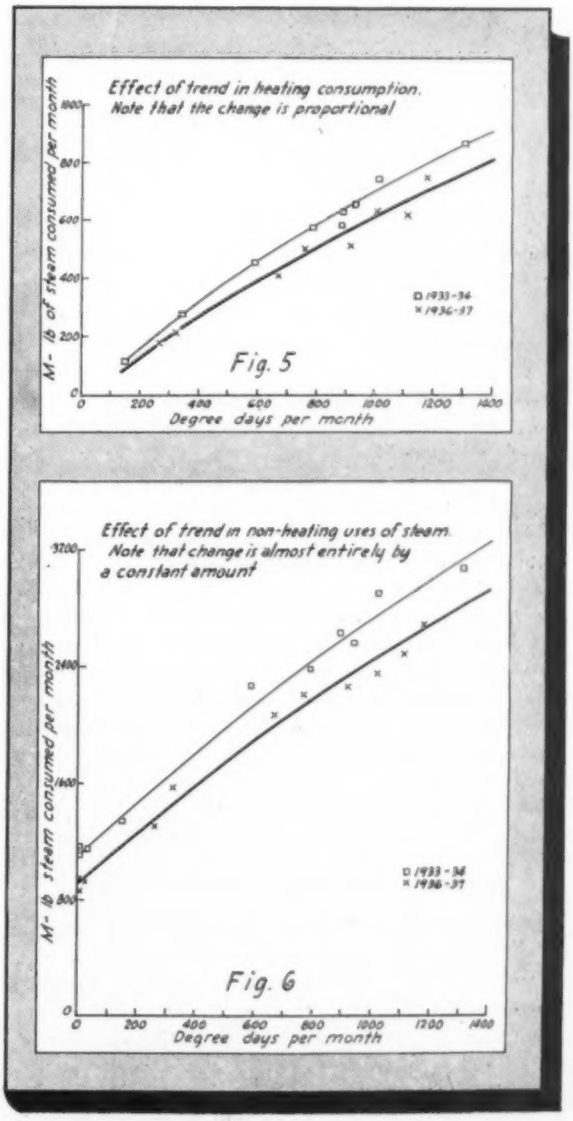
Meter No.	Name of Building	Deviation Ratio									
		Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
1	Total Steam	—	+1.1	+3.5	+0.6	+0.5	+3.9	—1.4	+1.2	+2.0	—
5	A	—	—0.6	+0.4	—2.0	+1.6	+5.1	+0.2	+2.3	+0.9	—
93	B	—	—0.9	0	—1.7	+2.0	+7.2	—1.5	—1.0	—0.6	—
103	C	—	+1.1	—1.1	—1.2	+1.2	+4.2	—1.5	+0.4	—4.1	—
106	D	—	—0.9	+0.8	—3.6	—2.3	—1.9	—0.8	+1.6	+1.8	—
107	E	—	—0.8	—1.2	—1.7	—4.6	—1.4	—1.6	+3.4	+0.3	—
110	F	—	—1.1	—1.1	+1.6	+2.5	+1.8	—0.8	+2.0	—1.0	—
117	G	—	—0.7	+2.7	+0.1	+2.7	+5.1	—1.4	+2.8	—0.2	—
119	H	—	—1.9	—2.6	+1.1	—0.5	—1.1	—0.6	+1.2	—0.8	—
Degree Days..		48	258	765	1011	1109	1177	915	671	326	76
Median Ratio .		—	+0.5	+0.1	+1.0	—0.2	+0.6	—1.4	—0.5	—0.3	—

Fig. 4—Sections from the monthly report

a high or low ratio for the group as a whole.

To facilitate the judgment of efficiency a summary table is included in the report. This states the frequency of the ratios in each unit interval. The median ratio for the entire group of buildings is also computed.

The median ratio may be regarded as an index of seasonal variation. It is computed by counting in the frequency table to find the middle ratio. This middle or median ratio, if it is near zero, indicates that the consumption for the group is normal. If it is significantly



above or below zero the consumption for the group may be regarded as similarly high or low. The reason for "abnormal" consumption will probably be the seasonal variation in use due to factors other than temperature. The cause of the variation should be sought, but when it is known the ratios may be interpreted with regard to the median ratio. Thus if the median ratio is—2 because of a week's suspension of activity in the group all the ratios may be regarded as being two intervals too low, and judged accordingly.

If the quartile deviations are accurately determined and if proper allowance is made for trends in the various buildings, 50 per cent of the ratios will lie within the range of ± 1. If, furthermore, the deviations are what is known statistically as "normally distributed", 95 per cent of the ratios will lie within the range of ± 3. Experience with one building group has shown that the ratios are not normally distributed, since more than 5 per cent of them lie outside the range of ± 3. This is probably because of three factors: (1) Steam meters are not perfect, and errors in the measuring mechanism creep in causing large ratios; (2) The uses of the buildings are always changing, making it impossible to make complete allowance for trends in consumption; and (3) since in many of the buildings the steam that is used for purposes other than heating is not metered separately, violent fluctuations in these uses cause large ratios.

However, on the basis of the data in the following table, ratios over ± 3 may be regarded as significant,

Distribution of the Ratios for All Buildings

Size of Ratio	Under —5	—3 to —4.99	—1 to —2.99	—0.99 to +0.99	+1 to +2.99	+3 to +4.99	Over +5
Number of Ratios	15	22	99	270	104	23	11
Percentage of Ratios	2.7	4.1	18.2	49.6	19.1	4.2	2.1

while a ratio larger than ± 5 is a definite indication that something is wrong. Frequently the meter will be found to be in error when large ratios are found. Large ratios also indicate trends in consumption in the various buildings.

In order that trends in consumption may be recognized, a recapitulation of the ratios over the past months of the current season is included in the report. To save clerical labor this form is returned to be brought up to date each month. If there is no trend the ratios for any particular building will tend to be one-half positive and one-half negative, about equal in size on each side of the curve. If there is a trend in heating consumption the ratios will tend to be positive if the trend is upward and negative if the trend is downward; the size of the ratios will tend to increase with increasing degree days. If the trend is due to changes in the other than heating uses the size of the ratios will not be related to degree days. When a trend is noticed it should be explained or corrected.

The "normal" curve charts are kept up to date and examined in conjunction with the monthly report.

The Yearly Report

At the end of each heating season the curves are inspected and adjusted (raised or lowered) to make allowance for any change in the consumption pattern (Figs. 5 and 6). If an adjustment is necessary because of changes in heating consumption the curve will be raised or lowered proportionally in all ranges of degree days, while if it is necessary because of changes in the other uses of steam the curve will be raised or lowered by a fixed amount. A report is made analyzing all adjustments made.

The deviations are also inspected. If the curve has been adjusted the deviations from the newer curve are used. The new quartile deviation is found and a report made comparing the quartile deviations for each year. In general, a decrease in the size of the quartile deviation is a desirable indication that consumption is being more closely regulated to temperature.

A word as to the uses of steam other than for heating. At the building group studied, these uses—hot water heating, equipment uses, and line losses—tend to remain relatively constant and unrelated to temperature, increasing slightly in the heating months, with seasonal variations more marked than in the heating uses. An average, or constant, with an appropriate quartile deviation, can be used to judge the efficiency of control of these uses.

Where the seasonal variations due to factors other than the temperature are marked, allowance can be made by comparing ratios of identical months in former years.

Although this method has been just recently developed, it has been useful in the few months it has been in operation for detecting errors in the meters and for pointing out trends in the early stages. The advantages claimed for it are simplicity, flexibility, and ease of application.

[Some of the more technical considerations which arose in the application of this method to a large group of buildings will be discussed in a second article.]

How Do You Know the Bolts Are Tight and Not Too Tight?

In making up bolted flanged connections, the necessity of tightening up the bolts to a predetermined stress, with each bolt carrying its proportionate share of the designated load, has been emphasized repeatedly in these pages and elsewhere.

Although the methods of achieving this result, *i.e.*, by elongation or torque,[1] are known, their application will be found to be largely a matter of theory, rather than of practice. This holds true, also, in many instances other than piping assembly; for instance it is essential that railroad track bolts be stressed definitely and equally.

Measuring elongation, while an excellent method, is too tedious when apparatus has to be opened up frequently for cleaning. Heat exchangers and similar apparatus must be serviced and returned to operation again in far too much of a hurry to permit bothering with micrometer measurements of bolting.

More speed can be made by employing the torque method, but the equipment for its application is seldom available. In the automotive industry, torque wrenches for tightening up cylinder head studs are in common use, but the largest ones are only ⅝ in. Many torque wrenches have been invented; but when tightening bolts from ¾ to 3 in., torque wrenches have to be improvised. Therefore, instead of controlling the operation, it is usually left to the judgment of a mechanic.

There is an utter lack of torque wrenches on the market, and industry needs such tools. Furthermore, sound methods of construction and assembly will not be generally attained until the proper equipment is forthcoming.—*Anon.*

[1] See "Flanged Piping Joints—Methods for Applying and Determining Bolt Stresses," by E. C. Petrie, Heating, Piping and Air Conditioning, June, 1936, pp. 303-309.

Pumping Head on Air Conditioning Systems Reduced by Using Siphon

By William Goodman*

AIR conditioning equipment requiring water must frequently be situated on an upper story of a building; for example, air cooling coils often are, and condensers sometimes are, placed on the top floor or the roof. If the water required for this equipment is obtained from either a city main or a deep well, it must be conducted back to a lower level to be wasted into the city sewers. If the water comes from an ice tank, it must also be conducted back to a lower level to be returned to the ice tank.

Under these circumstances, the possibility of substantially reducing the pumping head, or even sometimes of eliminating an otherwise needed pump, is often overlooked. This can be accomplished by utilizing the flow of water down the vertical discharge pipe to maintain a vacuum at the outlet of the elevated equipment. The maintenance of vacuums at the high point of piping systems by the flow of water down vertical pipes is not new, the most common example being the water siphon described in most elementary physics texts and used in waterworks practice. It is the purpose of this article, the first part of which was published last month, to call attention to the possibilities of utilizing these vertical discharge pipes; to discuss the underlying theory; and to mention a few practical pointers.

Long Vertical Drop of Discharge Pipes

So far only the conditions where a limited vertical drop is possible have been discussed. However, there are many places where discharge pipes having longer vertical drops than 34 ft can be installed.

Now, it has been previously shown that the pressure decreases above the open outlet at the bottom of a vertical discharge pipe, and that at a height of approximately 34 ft above the outlet, the pressure would be zero. Following this same line of reasoning, the pressure should be negative above a height of approximately 34 ft. This, of course, is physically absurd as the world of reality knows no such a thing as a negative *absolute* pressure. However, as there is nothing to prevent the installation of discharge pipes longer than 34 ft, the question naturally arises as to what happens in such a long pipe.

What actually happens in such a long vertical discharge pipe, which has no restriction at its outlet and only a low friction loss, is that the column of water breaks; that is, instead of flowing as a solid continuous stream, the water stream separates into numerous parts which only partially fill the pipe. The water falls freely down the pipe exactly as it does in a rain water conductor pipe carrying a small amount of water from a roof to the sewer. Although the water is delivered under pressure through the supply piping to the elevated equipment, the discharge pipe simply acts as a drain pipe conducting the water under approximately atmospheric pressure along its entire length.

In order to maintain the desired low pressure at the top of a discharge pipe, the water column must therefore be prevented from breaking. When a long vertical discharge pipe is to be used, the restraints imposed by Formula 1 must still be observed if the water column is to be maintained as a solid, continuous stream. This formula shows that the the friction loss of the discharge pipe must be increased, or a restriction must be installed at its outlet, if a vacuum is to be maintained at the top. For example, if the vertical drop is 50 ft and an absolute pressure of 10 ft is to be maintained at the top, Formula 1 shows that the sum of the pipe friction loss and the absolute pressure at the outlet must be 60 ft. If the outlet pressure is maintained at atmospheric pressure, or 34 ft, a discharge pipe small enough to produce a friction loss of 26 ft (60 — 34) would be required. As an alternative, a larger pipe line could be used and the remaining necessary pressure loss produced at the outlet by installing either an orifice or an adjustable valve there. This would seem to be the wiser course for many reasons.

When water-using air conditioning equipment must be situated above the source of water supply and a vertical discharge pipe of some length can be installed, it is often possible to reduce substantially the head against which the pump must deliver the water . . . No special equipment is needed, only an awareness of the possibilities of utilizing the energy of the falling stream of water, and some attention to a rather simple design and installation procedure

When ice is used to chill water, the return water is usually discharged over the ice through spray nozzles. Since a definite pressure is required ahead of the nozzles, it is apparent that, for purposes of computation, P_o of Formula 1 is the absolute pressure ahead of the nozzles. If the vertical drop of the discharge pipe is too long according to Formula 1, it is sometimes desirable to use nozzles having smaller orifices than might ordinarily be used, in order to maintain the pressure at the outlet of the discharge pipe high enough to prevent the water column from breaking. If it does break, a poorly formed spray will result due to lack of pressure.

When a Pump May Be Omitted

Sometimes when city water is used, its pressure may not be high enough to maintain the required flow of water against the combined friction and static heads of the pip-

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Part 2. Part 1 was published in the July issue, pp. 418-419 and 426.

ing system, if the water is to discharge from the elevated equipment against atmospheric pressure as in Fig. 2. Under these conditions, a pump would ordinarily be installed to provide the additional head needed. However, by utilizing the vertical discharge pipe to maintain a vacuum at the outlet of the equipment, a pump may sometimes be dispensed with entirely under these conditions.

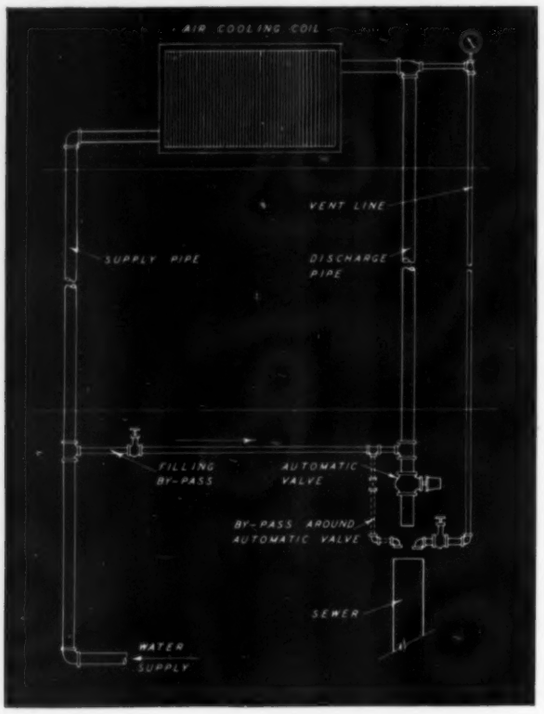


Fig. 3—Piping and valve layout arranged to take advantage of principle described in text

For example, after computing the head required to deliver a given quantity of water through a piping system, it is found that the city pressure lacks 15 ft of head of the required amount. Ordinarily a pump would be required to make this up. However, by designing the discharge pipe to maintain an absolute pressure of 19 ft (34 — 15) at the top of the discharge pipe, a pump may be dispensed with. Formula 1 can be used to find the minimum required vertical drop needed to maintain this vacuum. If the vertical drop is greater than this minimum required value, Formula 1 can also be used to find the pressure which must be maintained at the outlet of the discharge pipe by an orifice, or better still by an adjustable valve, in order to prevent the water column from breaking. Thus, to maintain a top pressure of 19 ft with a vertical drop of 40 ft, the sum of the friction loss in the discharge pipe and the absolute pressure at its outlet must be 59 ft, according to Formula 1. If the pipe friction amounts to, say, 12 ft, the outlet pressure must be 47 ft absolute. Since atmospheric pressure is 34 ft absolute, the drop in pressure through the outlet valve or orifice must be 13 ft (47 — 34).

Location of Automatic Valves

When using an automatic modulating valve in connection with a temperature control system, the best location for the valve is at the bottom of the discharge pipe, as shown in Fig. 3. If the valve is placed at either the inlet or the outlet of the elevated equipment, it may, when throttling the flow, reduce the pressure to such a low point that the water column will break.

Furthermore, if the automatic valve is installed at either the inlet or the outlet of the elevated equipment, the head on the pump will be increased by exactly the loss through the valve. On the other hand, if the valve is installed at the bottom of the discharge pipe, and if the vertical drop can be made long enough, there will be no increase in the pumping head because of the valve. Thus, suppose the computed net head against which a pump must work is 37 ft when an absolute pressure of 10 ft of water is maintained at the top of the discharge pipe. If an automatic valve having a loss of 15 ft is installed at the inlet to the coil, the net pumping head will be increased to 52 ft (37 + 15). On the other hand, if the valve is placed at the bottom of the discharge pipe, the net pumping head will still be 37 ft, if the discharge pipe can be made long enough to still maintain the absolute pressure of 10 ft at the top.

The vertical drop required for this purpose can be computed by Formula 1. As the valve has a loss of 15 ft, the absolute pressure at the outlet of the discharge pipe will be 49 ft (15 + 34). If the friction in the discharge pipe amounts to 5 ft, and the absolute pressure to be maintained at the top of the discharge pipe is 10 ft, the vertical drop should be 44 ft, according to Formula 1, in order to maintain an absolute pressure of 49 ft ahead of the automatic valve at the bottom of the discharge pipe. If the vertical drop cannot be made as long as this, the pressure at the top of the discharge pipe and hence the pumping head, will be increased somewhat by the installation of the valve at the bottom of the discharge pipe. Nevertheless, the increase in pumping head will often be less than if the valve were installed at the inlet to the elevated equipment.

Filling the Piping System with Water

To permit filling the piping with water, a valve is needed at the outlet of the discharge pipe, and a small vent valve is required at the high point of the piping for relieving air. For convenience in operation, a small vent line may be run from the top to a point beside the large valve on the discharge pipe outlet, as shown in Fig. 3. A filling bypass, also shown, enables the filling time to be reduced materially. When filling the piping, the valve on the outlet of the discharge pipe is closed and the bypass and vent valves opened. When water flows from the vent line, it signifies that the piping is filled, and the vent and filling bypass valves may be closed. The valve on the discharge line should then be opened slowly.

If the flow of water is stopped for a short time by the closing of an automatic valve at the outlet of the discharge pipe, it is probable that the flow will start again when the valve opens. Nevertheless, the problem of raising water to the highest point of the piping system is one that must be checked carefully for every installation in order to be certain that the piping system can be filled again if air accumulates at the high point during a shutdown period.

Very often, the pressure in a city main or the pressure which a pump can develop, with a very small delivery of water, is sufficiently high to raise water to the top of the piping even where the pressure is not high enough to maintain the required rate of flow against the

additional friction head at the full flow. In such a case, there will be no difficulty in filling the piping with water. While the piping is filling the flow may be small, but once the system is full, and the valve on the outlet of the discharge pipe is opened, the normal rate of flow will take place.

Where the city water pressure or the no-delivery head of the pump is not high enough to raise water to the top of the piping system, other provisions must be made. One way is to use a small auxiliary pump with a capacity of about 5 gpm for filling purposes only. Another is to use a water-operated air ejector; this method should be used only if the static water level stands rather high in the piping so that the volume of air to be exhausted from the remaining part of the piping system is relatively small. The time required to exhaust the air and raise the water should be checked if this method is used. Such an ejector should be installed at a low level in the building so that the water pressure available for its operation will be as high as possible. The vent line can be run from the high point of the piping down to the ejector.

If a vacuum pump is used on the heating system, it can sometimes be used to evacuate air from the upper part of the piping. The returns from the heating system should be valved off and the vent line from the high point of the water piping connected directly into the pump. The vacuum switch used for controlling the pump will ordinarily have to be short circuited, as the vacuum carried in heating systems is usually too low.

It should be borne in mind that the use of either the auxiliary pump, the ejector, or the vacuum pump is suggested only as a means for occasionally filling the piping system with water; they are not required during ordinary operation of the air conditioning equipment.

Continuity of Operation

In order to be sure that the flow of water will start again when an automatic control valve opens after having been closed, a small flow can be maintained while the valve is closed. This can be accomplished by leaving the vent valve in a partly open position if the vent line has been installed as shown in Fig. 3. Should the automatic valve close completely, sufficient water will flow through the vent line to insure continuity of operation when the automatic valve opens again.

If the vent line does not drop down to as low a point as the outlet of the discharge pipe, a small bypass can be installed around the automatic valve in order to maintain the flow; such a bypass is shown by the dotted lines in Fig. 3. If used for air cooling coils, the flow of water through the vent line or the bypass will not be wasted, since in every air conditioning system there is always some minimum load.

It is essential that the piping be absolutely tight if the system is to operate successfully. Because water at the high point of the piping is under a vacuum, air will leak into the piping system and break the water column if the joints are not tight. After the piping is installed, it should be tested at a vacuum as close to 30 in. as it is possible to obtain.

A vacuum gage at the high point of the piping system is of help in analyzing operating difficulties and in adjusting the valve at the outlet of the discharge pipe to maintain any desired absolute pressure, or vacuum, at the high point of the piping system. The vacuum gage readings corresponding to various absolute pressures, in feet of water, are:

Absolute Pressure Feet of Water	Vacuum Inches of Mercury
0	30.0
5	25.6
10	21.2
15	16.8
20	12.4

[*Concluded*]

Ten Mile Industrial Pipe Line Conveys 8,000,000 Gallons of Water Per Day

ONE of the largest industrial pipe line jobs of recent years was recently completed for the Southern Kraft Corp.'s, Georgetown, S. C., paper mill. More than 1400 tons of spiral butt welded pipe were used in 50,000 ft of pipe line. Nearly 10 miles are covered by the line from the Black river to the paper company's plant. It is designed to deliver 8,000,000 gallons of water a day to the mill.

Spiral welded pipe, 24 in. I.D., was used by the contractor. The pipe has a spun lining to prevent reduction in capacity of the line, and an outside coating of bitumastic enamel. Exterior of the pipe was covered with 15 lb asbestos felt wrap, whitewashed to reflect the sun's heat enroute to Georgetown and during the work of installation. All coatings were applied at the mill before shipment was made.

Sixty-five 50 ft railroad cars, each loaded with sixteen lengths of pipe, were required for the shipment. Trucks were used to carry most of the pipe from the railroad cars to the site. For laying the pipe over three miles of swamp land, however, it was necessary to set up 1000 ft of narrow gage railroad track, heavy enough to support a hand car with a section of pipe. After the trench was dug in the swamp land, the ends of each section of pipe were closed with wooden blocks. The sections then were lowered into the water and were pulled down the water-filled trench to the sections already in place.

The wooden blocks were removed at the time the couplings were installed. When water entered, the pipe sank to the ground level. This method was made possible only by the use of flexible couplings. The couplings have quarter-inch middle rings, conventional gaskets and followers on the sides. Fourteen bolts, requiring only a small hand wrench for fastening, made the joints water-tight. In the first test at a pressure of 100 lb per sq in., leaks were found only at the flanges on three valve installations. The pipe was subjected to hydrostatic tests of 350 lb per sq in. at the mill.

The line is relatively uniform from the Black river to the plant, although the reservoir at the paper mill is about 20 ft higher than the pumping station at the source. Automatic air and vacuum valves are placed at the high points, and blow-off valves at the major low points.

Power at the river is furnished by two high speed centrifugal pumps, driven by 150 hp diesel engines.

[*Concluded on p.* 483]

Effect of City Water Supply and Sewer Systems on Air Conditioning Reported

PRACTICALLY every large city in the country needs to make an accurate survey of the problem of the effect of water supply and sewerage facilities on air conditioning, according to a report[1] by O. C. Holleran just issued by the Bureau of Foreign and Domestic Commerce of the Department of Commerce.

From January, 1933, through December, 1936, the number of air conditioning installations increased 1400 per cent, the report states, and 40 per cent of all installations depend on local water supplies, 60 per cent using cooling towers or being air-cooled. It was determined by questionnaire that 38 of the cities replying have taken steps to limit the use of water-using air conditioning equipment or are considering doing so. Some cities are now using the full capacity of their water systems,[2] others are using 75 to 96 per cent of their capacity,[3] and in some places the sewer systems are so limited that uneconomical use of water for air conditioning plants is being discouraged.[4] Obviously, since demand for air conditioning equipment is a growing factor, cities will be forced to provide more capacity.

Laying 36 in. cast iron water service main at Baltimore, Md.

In addition to the general discussion of the problem, a number of tables (one of which is reproduced here) are presented in the report, covering cities of 100,000 population and over. Table 1 shows detailed figures on available water supply by cities, population served, the type of the source of supply—a matter of importance, since expansion of production of water is generally easier from surface sources than from wells. The delivery capacity of the water works system is included in this table to indicate the relation of current potential drawdown to reserves.

Table 2 gives the total actual annual delivery of water in gallons, by cities, and is valuable as a means of visualizing the operations of the water service in each of these communities. In addition to the figures on actual delivery, the percentage of annual change by years is also included. Many of the cities that are reported as the best markets for air conditioning equipment have shown the greatest increase in gallonage in 1936 over 1935. Although city authorities in general have not been able to specify what actual part of the increase is due to the installation of air conditioning equipment and what part is due to increased business activity in general, it is obvious that in many cases a large percentage of the increased and increasing demand for water comes from the draw-down by the air conditioning equipment in operation in the city.

Available Water Facilities

Table 3 is designed to give a comparison of the available water facilities on a per capita basis, the expansion and demand which can be met without additions to the system, and the per cent of increased demand that can be met by the present facilities by major factors. The latter section of the table is included for the purpose of segregating as far as possible the bottle neck in each city system. The data in this table definitely show the source of the limitation for marketing water-using air conditioning equipment likely to be met during the next several years; also, what markets manufacturers should consider as particularly valuable for selling self-contained conditioning units. Thus in the case of Atlanta, Ga., Chattanooga, Tenn., Columbus, Ohio, St. Paul, Minn., Scranton, Pa., and South Bend, Ind., present water facilities are being used to capacity and no additional gallonage of any moment can be delivered until added water works plants are provided. In some cities additional delivery is dependent upon one factor only, thus in Louisville, Ky., the system must have more pumping capacity in order to appreciably increase its delivery capacity; the treatment plant, storage equipment and mains are ample to take care of 60 per cent more water than is now being used by the city but pumping equipment can deliver an increase of only 30 per cent. In St. Paul, on the other hand, additions are needed to both mains and pumping capacity as well as to treatment facilities. The latter are now under construction and within a few months the city will be able to increase its service to some extent. The other cities in this group (Atlanta, Columbus, and South Bend) report that they need extensive additions to practically each of their major facilities before additional service on a large scale will be available.

There is a secondary group of cities, many of which

[1] "Effect of City Water and Sewerage Facilities on the Market for Air Conditioning," by O. C. Holleran, Marketing Research Division, Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C. Price, 10c.

[2] Among them Atlanta, Ga.; Chattanooga Tenn.; Columbus, Ohio; Dallas, Tex.; St. Paul, Minn.; Scranton, Pa.; South Bend, Ind.

[3] Among them Cambridge, Mass.; Dayton, Ohio; El Paso, Tex.; Hartford, Conn.; New York, N. Y.; Oklahoma City, Okla.; Philadelphia, Pa.; Pittsburgh, Pa.; Springfield, Mass.; Syracuse, N. Y.; Utica, N. Y.; Waterbury, Conn.; Worcester Mass.

[4] Chicago "Loop" district, for instance.

Temperature of Water at Main Outlet and Normal Mean Air Temperature for Selected Months in Cities of 100,000 Population and Over, in Fahrenheit Degrees, 1936

City and State	Normal Mean Temperature						Temperature of Water at Main Outlet					
	April	May	June	July	August	Sept.	April	May	June	July	August	Sept.
Akron, Ohio	48.0	59.2	68.2	72.5	70.5	64.7	43.7	61.0	69.3	74.3	74.7	69.4
Albany, New York	46.8	59.3	68.0	72.6	70.8	63.1	40.0	52.0	60.0	56.0	66.0	65.0
Atlanta, Georgia	61.0	69.9	76.0	78.1	77.0	72.4	59.0	71.5	78.1	83.5	79.5	77.8
Baltimore, Maryland	53.6	64.4	72.7	77.2	75.5	68.5	47.0	53.0	61.0	66.0	70.0	64.0
Birmingham, Alabama	63.3	71.1	77.9	80.2	79.2	74.8	63.0	73.0	78.0	82.0	81.0	79.0
Bridgeport, Connecticut	47.8	58.5	66.8	72.8	70.7	65.2	43.0	45.0	53.0	62.0	65.0	66.0
Boston Metro. District	46.4	57.1	66.5	71.7	69.9	63.2	/1	/1	/1	/1	/1	/1
Buffalo, New York	42.8	54.6	64.4	69.8	68.0	62.4	32.0	37.0	62.0	71.0	73.0	66.0
Cambridge, Massachusetts	46.4	57.1	66.5	71.7	69.9	63.2	43.0	55.0	64.0	72.0	74.0	68.8
Camden, New Jersey	52.1	62.9	71.4	76.2	74.8	68.0	•	•	•	•	•	•
Canton, Ohio	48.4	59.3	68.1	72.1	70.0	64.2	/2	/2	/2	/2	/2	/2
Chattanooga, Tennessee	60.3	68.8	75.4	78.4	77.5	72.2	64.0	67.0	73.0	79.0	79.5	76.5
Chicago, Illinois	46.9	57.5	67.3	72.5	71.6	65.2	39.2	47.1	55.4	68.0	69.4	62.5
Cincinnati, Ohio	52.4	63.1	71.2	75.1	73.6	67.1	49.0	66.0	76.0	82.0	81.0	77.0
Cleveland, Ohio	46.2	57.9	67.1	71.4	70.0	63.9	39.0	50.0	58.0	68.0	73.5	71.0
Columbus, Ohio	51.2	62.3	70.9	74.9	73.0	66.5	46.0	64.0	72.0	76.0	76.0	74.0
Dallas, Texas	65.0	72.3	79.9	83.6	83.0	76.9	65.0	66.0	77.0	82.0	82.5	74.0
Des Moines, Iowa	50.1	61.3	70.6	75.4	73.1	65.6	44.1	49.1	58.2	65.7	72.9	71.1
Detroit, Michigan	46.2	58.0	67.4	72.1	70.3	63.5	41.0	56.0	64.0	75.0	74.0	68.0
Denver, Colorado	51.6	62.6	71.4	75.4	73.4	66.6	54.3	61.7	63.1	70.9	70.7	68.0
Dayton, Ohio	47.1	56.2	66.3	72.2	70.7	62.9	/1	/1	/1	/1	/1	/1
Duluth, Minnesota	37.0	47.3	57.2	63.9	62.6	55.1	33.4	52.7	57.6	70.6	66.6	58.7
Elizabeth, New Jersey	50.9	61.7	70.4	75.2	73.2	66.9	43.3	48.8	51.7	54.7	61.3	66.7
El Paso, Texas	63.4	71.5	79.6	81.1	79.2	73.9	80.0	82.0	84.0	85.0	85.0	84.0
Erie, Pennsylvania	45.1	56.8	66.2	71.0	69.6	63.6	36.9	53.7	63.8	72.3	72.9	69.8
Evansville, Indiana	56.7	66.7	75.1	78.9	77.4	70.7	56.0	66.0	85.0	84.0	83.0	74.0
Fall River, Massachusetts	46.3	56.9	65.3	71.0	69.2	63.1	/1	/1	/1	/1	/1	/1
Flint, Michigan	45.1	56.3	66.0	70.6	67.7	61.6	/1	/1	/1	/1	/1	/1
Fort Wayne, Indiana	49.0	60.1	68.5	73.7	71.2	65.1	49.0	67.0	73.0	79.0	78.0	73.0
Fort Worth, Texas	65.0	72.3	79.9	83.6	83.0	76.9	62.0	72.0	81.0	83.0	83.0	81.0
Gary, Indiana	46.9	57.5	67.3	72.5	71.6	65.2	41.0	50.0	60.0	70.0	70.0	65.0
Grand Rapids, Michigan	47.0	58.0	67.8	72.3	69.7	62.7	54.0	66.0	71.0	73.0	74.0	69.0
Hartford, Connecticut	46.7	57.5	67.1	71.6	68.9	61.7	44.0	54.0	59.0	66.0	70.0	69.0
Houston, Texas	69.3	75.5	81.4	83.7	83.2	79.0	84.0	84.0	84.0	84.0	84.0	84.0
Indianapolis, Indiana	52.1	62.9	71.6	75.7	73.7	66.9	53.0	68.0	73.0	80.0	82.0	77.0
Jacksonville, Florida	68.7	75.0	79.9	82.1	81.7	78.3	79.2	80.6	84.8	86.3	86.7	82.4
Jersey City, New Jersey	49.4	60.6	68.8	73.8	73.1	66.8	•	•	•	•	•	•
Kansas City, Kansas	54.8	64.8	73.6	78.1	76.6	68.9	63.0	78.0	84.0	93.0	91.0	85.0
Kansas City, Missouri	54.8	64.8	73.6	78.1	76.6	68.9	/1	/1	/1	/1	/1	/1
Knoxville, Tennessee	58.0	67.2	74.0	77.1	76.2	70.6	59.2	75.6	81.5	84.0	84.3	79.9
Long Beach, California	59.4	62.2	66.4	70.2	71.1	69.0	/1	/1	/1	/1	/1	/1
Los Angeles, California	59.4	62.2	66.4	70.2	71.1	69.0	63.0	68.0	73.0	74.0	76.0	75.0
Louisville, Kentucky	56.4	66.6	74.7	78.6	77.0	70.5	49.0	69.0	77.0	82.0	82.0	77.0
Lowell, Massachusetts	46.4	57.1	66.5	71.7	69.9	63.2	50.0	50.0	50.0	50.0	50.0	50.0
Lynn, Massachusetts	46.4	57.1	66.5	71.7	69.9	63.2	/1	/1	/1	/1	/1	/1
Memphis, Tennessee	61.8	70.6	77.6	80.7	79.4	73.6	/1	/1	/1	/1	/1	/1
Miami, Florida	72.8	76.4	80.0	81.0	81.4	80.1	/3	/3	/3	/3	/3	/3

Temperature of Water at Main Outlet and Normal Mean Air Temperature for Selected Months in Cities of 100,000 Population and Over, in Fahrenheit Degrees, 1936

City and State	Normal Mean Temperature						Temperature of Water at Main Outlet					
	April	May	June	July	August	Sept.	April	May	June	July	August	Sept.
Milwaukee, Wisconsin	43.8	54.1	63.9	70.1	69.2	62.5	38.4	42.8	49.7	57.0	60.6	56.6
Minneapolis, Minnesota	46.4	57.7	67.5	72.3	69.9	61.4	40.5	61.2	69.3	80.2	73.0	67.6
Nashville, Tennessee	59.0	68.2	75.6	79.1	77.8	71.8	61.0	76.0	84.0	88.0	88.0	84.0
Newark, New Jersey	49.4	60.6	68.8	73.8	73.1	66.8	45.0	56.0	64.0	68.5	71.5	70.5
New Bedford, Massachusetts	45.9	56.3	65.1	70.7	68.8	62.8	42.0	48.0	60.0	68.0	71.0	69.0
New Haven, Connecticut	47.2	57.9	66.6	71.8	70.3	63.5	50.0	/1	/1	/1	70.0	60.0
New Orleans, Louisiana	68.8	75.4	80.6	82.4	82.2	79.2	66.0	77.0	86.0	89.0	90.0	90.0
New York, New York	49.4	60.6	68.8	73.8	73.1	66.8	45.0	55.0	63.0	70.0	70.0	69.0
Norfolk, Virginia	56.8	66.2	74.4	78.7	77.4	71.6	62.0	70.0	77.5	83.0	83.0	79.5
Oakland, California	55.8	58.4	61.8	61.5	61.0	62.2	55.0	57.0	59.0	62.0	64.0	64.0
Oklahoma City, Oklahoma	60.5	68.4	77.8	82.0	82.1	75.0	55.4	68.0	73.4	77.2	77.0	72.4
Omaha, Nebraska	51.2	62.4	71.6	76.7	74.4	66.8	50.8	55.8	68.0	80.9	79.4	69.1
Paterson, New Jersey	50.7	61.5	70.0	74.5	72.2	66.4	46.0	49.2	54.6	55.9	59.0	64.0
Peoria, Illinois	50.9	61.7	70.9	75.4	72.5	64.3	54.0	54.0	56.0	56.0	56.0	54.0
Philadelphia, Pennsylvania	52.1	62.9	71.4	76.2	74.8	68.0	40.0	68.0	71.0	79.0	77.0	72.0
Pittsburgh, Pennsylvania	51.2	62.4	70.7	74.6	72.9	69.4	46.4	66.2	75.2	80.6	80.6	75.2
Portland, Oregon	51.8	56.9	62.4	66.7	66.7	61.7	43.7	50.0	56.0	62.0	55.0	51.6
Providence, Rhode Island	46.6	58.5	68.3	73.4	71.0	63.2	48.0	56.0	62.0	64.0	65.0	63.0
Reading, Pennsylvania	50.3	62.5	69.8	75.5	72.4	66.3	46.4	59.9	70.7	78.8	76.1	71.6
Richmond, Virginia	56.6	66.5	74.1	78.5	76.5	70.5	56.8	69.6	74.7	80.4	79.5	73.4
Rochester, New York	44.9	57.1	66.1	70.7	69.2	62.4	41.9	52.8	62.3	68.0	68.9	64.6
St. Louis, Missouri	56.1	67.0	75.0	78.8	77.5	70.5	53.0	69.0	77.0	85.0	83.0	75.0
St. Paul, Minnesota	45.6	57.9	67.1	72.1	69.4	61.3	/1	/1	/1	/1	/1	/1
Salt Lake City, Utah	49.6	57.4	67.4	75.7	74.5	64.4	50.0	50.0	58.0	58.0	57.0	50.0
San Francisco, California	55.0	56.8	58.5	58.5	59.1	60.9	60.0	60.0	60.0	60.0	60.0	60.0
San Antonio, Texas	69.1	75.1	81.0	83.8	83.5	79.0	76.0	76.0	76.0	76.0	76.0	76.0
Scranton, Pennsylvania	48.1	59.4	67.8	71.7	69.8	62.0	/1	58.2	64.1	70.3	70.9	67.9
Seattle, Washington	49.4	54.5	59.0	63.1	63.1	58.1	/1	/1	/1	/1	/1	/1
South Bend, Indiana	47.9	59.2	68.4	73.4	71.4	65.2	/4	/4	/4	/4	/4	/4
Spokane, Washington	48.4	55.5	62.8	69.0	68.1	59.2	/5	/5	/5	/5	/5	/5
Springfield, Massachusetts	47.3	58.3	67.8	72.6	70.8	62.6	41.0	49.0	52.0	54.0	55.0	54.0
Syracuse, New York	44.7	57.7	65.6	70.6	68.8	61.8	44.2	50.5	59.8	66.4	70.4	67.7
Tacoma, Washington	48.7	54.1	58.7	62.8	62.6	57.3	49.0	51.0	53.0	59.0	61.0	60.0
Tampa, Florida	70.9	76.3	80.2	81.2	81.5	79.9	80.0	85.0	87.0	85.0	85.0	83.0
Toledo, Ohio	47.6	59.4	68.7	73.2	71.3	64.4	48.0	66.0	72.0	87.0	85.0	72.0
Trenton, New Jersey	49.8	61.1	69.5	74.6	73.0	66.9	/1	/1	/1	/1	/1	/1
Tulsa, Oklahoma	60.5	68.4	77.8	82.0	82.1	75.0	62.2	70.0	77.2	81.8	81.8	79.1
Utica, New York	43.8	56.4	65.2	69.3	66.9	58.8	43.2	53.6	63.0	70.0	70.2	67.6
Washington, D. C.	53.3	63.7	72.2	76.8	75.0	68.1	49.0	49.0	43.0	67.0	73.0	75.0
Waterbury, Connecticut	47.8	59.0	67.5	72.5	73.3	63.9	47.0	64.0	68.0	74.0	74.0	73.0
Wilmington, Delaware	56.4	65.1	74.4	79.4	78.3	70.6	52.0	68.0	73.0	78.0	79.0	73.0
Wichita, Kansas	52.6	63.1	71.4	76.3	74.0	68.3	*	*	*	*	*	*
Worcester, Massachusetts	45.7	57.3	66.2	71.2	68.9	62.3	46.0	53.5	65.0	70.0	73.0	68.5
Yonkers, New York	49.4	60.6	68.8	73.8	73.1	66.8	60.0	69.0	75.0	77.0	79.0	78.0
Youngstown, Ohio	49.3	59.7	69.4	72.3	69.2	63.6	43.0	50.5	58.5	62.5	66.0	68.5

1/ Data not on schedule.
2/ Average of 55 degrees the year round.
3/ Varies from 70 - 75 degrees the year round.
4/ Average of 60 degrees the year round.
5/ Average of 47 degrees the year round.
* Schedule not returned.

because of their climate, constitute outstanding potential markets for air conditioning equipment, which are likely to be considerably limited in the near future by one or more of the major factors or by their water supply system reaching its service capacity. Thus Baltimore, Md., now using approximately 75 per cent of its delivery capacity, will shortly be in need of seeking new sources of raw water supplies. Buffalo, N. Y., using 73 per cent of its present capacity, reports a possible expansion of 25 per cent from present water sources with present facilities for storage, treatment, and pumping. Dayton, Ohio, using 84 per cent of its capacity is another potentially excellent air conditioning market which may soon be limited by lack of raw water resources, while El Paso, Tex., now using 94 per cent of its present capacity, will need additional plant before further considerable expansion in delivery is possible.

Table 4 gives such detailed information concerning the operation of water-using air conditioning installations as were available in city records. Perhaps the most important fact developed by this table is the obvious need for city water authorities of each community to make a complete census of air conditioning equipment which they are serving, showing the installed horsepower, the tonnage of refrigeration supplied by each installation, and the gallonage of water which they draw from the city system, as well as the method of disposing of the waste water.

It appears that in many cities the drain on the water system is being felt with sufficient severity to justify consideration of limiting ordinances of one sort or another, but that very little actual data have been accumulated to show just what the drain may be in comparison to the total facilities of the cities, or whether the extra demand which is straining the system is really due to air conditioning use. This is an exceptionally serious situation for the manufacturer of air conditioning apparatus, as he may find his product blamed and his market limited by a situation caused by some other condition.

Data on Water Temperatures

Table 5 (reproduced here) has been compiled for reference purposes because of the importance of temperature factors of both air and water in affecting the size of installations necessary to achieve a given result. Figures for air temperatures are from the records of the U. S. Weather Bureau. Temperatures of water at main outlets by cities are from data furnished by the individual city water authorities.

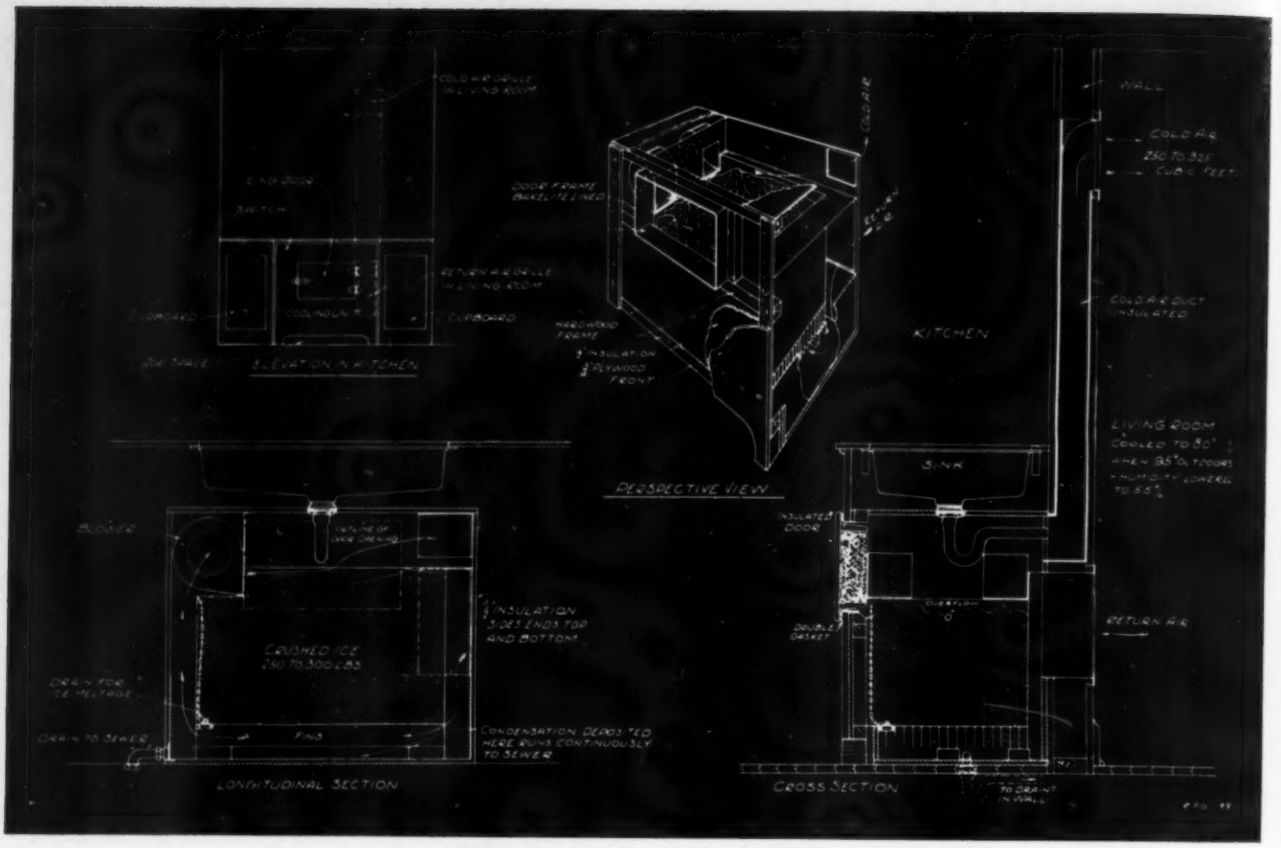
One of the important facts developed by these temperature comparisons is the reversal in position of air and water temperatures in August and September. In general, from April through July water temperatures are below the normal mean air temperatures, but in practically every city this situation is reversed during August and September, the water temperatures at main outlets running as much as 16 degrees higher than the air temperature. Obviously this condition indicates that the use of water in air conditioning installations in the late summer will increase by a considerable gallonage over usage during the earlier months of the summer unless steps are taken for conservation.

[*Concluded from p.* 479]

The line is subject to practically all kinds of soil conditions. Part of the line is through heavy timbered country, another large portion is through sandy loam, and about three miles of the pipe courses through heavy cypress swamp.

First shipment of the pipe arrived on March 13 and the line was tested May 25. As much as 2800 ft of pipe was laid in a day. No skilled labor was used. The laying crew comprised a foreman and seven helpers; two men for tightening the couplings, and one for coating the couplings.

A comparatively straight section of the 10 mile line. Eleven men finished the job in 70 days. *Inset*—Small hand wrenches were all that unskilled laborers needed to tighten the bolts on the couplings Photographs courtesy American Rolling Mill Co.



Details of the apartment cooling units

Ice Cools New Apartment Building

By **E. O. Young*** **[as told to Francis A. Westbrook]**

THE Larchmere-Moreland Apartment in Cleveland is the first apartment house in the city equipped for comfort cooling. One of the most interesting features of the summer cooling is that it is applied to apartments that rent for from $70 to $100 a month, and that it is economically practicable to do so.

There are 36 apartments in the building, consisting of five and six rooms each. Each living room is individually conditioned by equipment installed in the kitchen. The cooling unit consists of a condensation tank and an ice tank. The lower portion of the tank has fins which act as cooling surfaces similar to cooling coils and tend to dehumidify the air. The air inlet is 10 in. above the floor of the living room, which is on the opposite side of the wall from the side of the kitchen where the unit is located. As the air enters the cooling unit at this point it is drawn over and around the cooling fins, spaced 1 in. apart, by fans in a chamber at the opposite end of the unit. The cooled air is then blown over the ice tank and into the supply duct which leads directly to the living room.

A 1/20 hp 2 speed motor drives the blowers, with a switch on the front where it is accessible. Two sizes of unit are used; one has a fan capacity of 250 cfm which, with 200 lb of ice per day, has been calculated as sufficient for the smaller apartments. The other size has a 325 cfm fan and is for the larger apartments, which use 300 lb of ice per day. The unit as a whole is of galvanized sheet metal construction, lined with ½ in. insulation. The front is of wood and has a door through which the fan and motor may be removed for repairs. The lengths of the units are 36 and 48 in., height is 30 in., and depth 23 in.

The ice used consists of 3 in. cubes. Each tenant makes his arrangements with the City Ice & Fuel Co. The company offers special rates to keep the ice tanks filled, or the tenant may

[*Concluded on p.* 491]

*Owner, E. O. Young Co.

Each of the 36 apartments in this Cleveland apartment building has its own ice-using comfort cooling unit. The ice tank for each apartment is situated under the sink in the kitchen, and the air is conveyed through a short duct to the living room on the opposite side of the wall . . . . 3 in. cubes of ice are delivered in bags

Formulas for Stresses in Bolted Flanged Connections

By E. O. Waters*, D. B. Wesstrom**, D. B. Rossheim†, and F. S. G. Williams††

SO far, the earlier work has been reviewed and the basis of the present study discussed. The tapered hub flange without hydrostatic pressure was analyzed last month, and we continue with an analysis of the tapered hub flange with hydrostatic pressure and no bolt load. Illustrative problems are included.

Tapered Hub Flange With Hydrostatic Pressure and No Bolt Load

There is an apparent paradox in the title of this section, in that the externally applied forces are not balanced in the axial direction. Actually, the axial pull on the shell may be thought of as balanced by a virtual pull on the contact face of the ring, upon which is superposed a couple of sufficient magnitude to give a resultant pressure on the contact face; and since the stress effects of this couple are completely determined by the methods given earlier in this paper under "Analysis of Stress Distribution," the hydrostatic end force on the shell and the virtual pull on the ring face are the only axial loads that need be considered here. It must further be observed that point O shown in Fig. 3, can no longer be considered as fixed, since the hydrostatic pressure tends to stretch both hub and ring, whereas in the method given earlier in this paper under "Analysis of Stress Distribution" the shearing action at the interface tends to stretch one part and shrink the other, so that the net effect can, with some justification, be disregarded. With these preliminaries, a stress analysis will now be outlined.

The radial force acting outward on the ring at its inside diameter is $p - P_1/t$ per unit area, and the radial displacement of point O' shown in Fig. 3 may be found by the usual thick-cylinder analysis. The displacement y_1 of point O is greater than this by $-{}^1/_2\,\theta t$; this gives a relation between y_1, P_1 and θ. Secondly, the rotation between the hub and the ring at O is found by letting $W_1=0$ in Equation [2] and solving for θ; this gives a relation between θ and M_{r1}, or θ, M_{h1}, and P_1. The hub and shell equations are identical with Equations [4] and [5] except that the right-hand members have a constant term proportional to p/E which gives, in the solution for y, the membrane expansion due to p with discontinuity effects neglected. All told, there are six constants of integration (four in the solution of the hub equation and two in that for the shell); and since there are four identical elastic conditions at the shell-hub interface and two independent relations established for the ring, the necessary and sufficient equations exist for evaluating them.

Unfortunately, the computations for a single problem are extremely laborious; however, it would be possible to derive a set of F and V values analogous to those presented previously in this paper, in which the combined rotation and expansion of the ring are taken into account, and which could be used in simplified formulas like Equations [8], [9], and [10], but with M replaced by p, to compute the first and second peaks of stress caused by the internal pressure.

It may also be suggested that, since the discontinuity stresses due to pressure are apt to be much smaller than those due to bolt pull, it is not necessary to compute them with any great precision. Suppose, for a first approximation, that the tapered hub and shell are replaced by a shell of constant thickness g_0, and that the ring is wide enough to prevent expansion of this assumed hub at its constrained end. If there is no rotation of the ring, the existence of internal pressure causes a large positive moment at the junction with the hub, which is of no consequence as it is counteracted by a negative moment at the same location due to bolt pull; furthermore, the first peak of negative moment due to internal pressure is so small as to be inconsequential. On the other hand, if we permit the end of the assumed hub to rotate freely, at the same time constraining it against expansion, we obtain a zero moment at the junction of hub and ring, and a negative movement at some distance from this point, which is in general of the order of magnitude of the negative peak of moment that occurs in the actual hub-shell combination under pressure from within. The extreme fiber stress due to this moment may be combined with the stress due to the hydrostatic end force, and with the maximum bending stress in the hub due to bolt pull, if the latter occurs at the small end of the hub, to get an approximate value of the maximum longitudinal stress due to both internal pressure and bolt pull. If the maximum longitudinal hub stress due to bolt pull alone occurs at the large end of the hub, it is considered unlikely that a much greater longitudinal stress, due to combined bolt pull and internal pressure, occurs at any point whatever.

The mathematical expression for the maximum longitudinal stress in the hub, caused by internal pressure, is greatly simplified by this approximation. Using

$$y = e^{\beta x}\,(c_9 \sin \beta x + c_{10} \cos \beta x) + \left(1 - \frac{\nu}{2}\right)\frac{r_1{}^2 p}{g_0 E}$$

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This paper was contributed by the power division for presentation at the semi-annual meeting of the *American Society of Mechanical Engineers*, Detroit, Mich., May, 1937, and is published here by permission.
Part 3. Part 1 was published in June, pp. 363-366, and Part 2 in July, pp. 431-434.

and its first and second derivatives, and specifying that $y = M_h = 0$ when $x = 0$, it is found that the integration constants become

$$c_9 = 0 \text{ and } c_{10} = -\left(1 - \frac{\nu}{2}\right)\frac{r_1^2 p}{g_0 E}$$

Substituting these in the equation for the moment and its first derivative, the maximum moment in the hypothetical hub, due to pressure, is found to occur at a distance $x = -\pi/4\beta$ from the back of the ring, and its value is

$$M_h = -\left(1 - \frac{\nu}{2}\right)\frac{pe^{-\pi/4}}{(2\sqrt{2})\,\beta^2}$$

The corresponding longitudinal tensile stress in the outer surface of the hub, assuming $\nu = 0.3$ is

$$S_1 \approx 0.5 r_1 p / g_0$$

In other words, the maximum stress in the outer fibers of the hub, due to bending caused by internal pressure, is of the same magnitude as the direct tensile stress in the shell due to the hydrostatic end force.

Illustrative Problems

A few illustrative problems are given as an aid to a clear understanding of the charts and design formulas. In the second and third problems, a calculation of the bending stresses along the hub and shell has been made, showing the separate effects of bolt load and hydrostatic pressure. This requires the use of formulas and methods which are only outlined in the present paper, but are given in complete detail in the authors' report, previously referred to (8).

Example 1. Given an integral flange with the following dimensions: $A = 44\frac{1}{8}$ in., $B = 36\frac{5}{8}$ in., $t = 2\frac{1}{8}$ in., $g_0 = 1$ in., $g_1 = 1\frac{1}{2}$ in., $h = 3\frac{1}{8}$ in. Find the critical stresses S_H, S_R, S_T, assuming that the bolting is such as to give a ring moment of 402,000 in-lb.

The design factors are: $M = 10976$, $K = 1.2048$, $g_1/g_0 = 1.5$, $h/\sqrt{Bg_0} = 0.5164$, $t/g_0 = 2.9375$, $\sqrt{B/g_0} = 6.05186$. From Fig. 4, $F = 0.847$, $V = 0.310$, and entering Fig. 7 with K, it is found that $T = 1.835$, $U = 11.91$, $Y = 10.4$, $Z = 5.60$. According to Fig. 6, $f = 1$. By calculation, $X = 1.139$, and the three stresses that may be critical are, in round numbers: $S_H = 5500$ lb per sq in., $S_R = 2200$ lb per sq in., and $S_T = 700$ lb per sq in.

This flange is designed to carry an internal pressure of 75 lb per sq in., which gives a longitudinal membrane stress of only 460 lb per sq in. at the large end of the hub, negligible in comparison with S_H. At the small end of the hub the longitudinal membrane stress is 700 lb per sq in., which, as previously stated, may be taken as a rough indication of the maximum bending stress that may be expected from the internal pressure.

If we compare the stress conditions in this flange as just computed with those in an identical flange not secured to a shell, i. e., a loose flange with hub, we find that F and V have new values. These, as obtained from Fig. 5 are $F_L = 1.52$ and $V_L = 0.98$. This changes X to 0.773, and the three stresses become $S_H = 3770$ lb per sq in., $S_R = 1950$ lb per sq in., and $S_T = 2290$ lb per sq in. If the hub of the loose flange is made progressively shorter, it will be found that S_H and S_R approach zero, while S_T becomes the critical stress and approaches its maximum value of 13,230 lb per sq in.

Example 2. A filter shell flange has the following dimensions: $A = 127$ in., $B = 120\frac{1}{4}$ in., $t = 2\frac{1}{8}$ in., $g_0 = 5\frac{1}{8}$ in., $g_1 = 1\frac{1}{8}$ in., $h = 3\frac{1}{8}$ in., bolt-circle diameter $= 124\frac{1}{2}$ in., outside diameter of gasket $= 123$ in., inside diameter of gasket $= 121\frac{1}{4}$ in. Thirty-six $1\frac{1}{2}$-in., bolts are used, with an allowable stress of 20,000 lb per sq in. Using a slight modification of the method specified in the A.S.M.E. Code for Unfired Pressure Vessels for computing the effective loading on the ring, in accordance with the practice of certain designers, the equivalent ring moment Wa is assumed equal to 903,000 in.-lb.

The various factors in the design formulas are then as follows: $K = 1.0561$, $g_1/g_0 = 1.8$, $h/\sqrt{Bg_0} = 0.3605$, $F = 0.852$, $V = 0.293$, $T = 1.90$, $U = 39.0$, $Y = 35.2551$, $Z = 18.3295$, $t/g_0 = 4.7$, $\sqrt{B/g_0} = 13.8708$, $X = 1.3427$, $M = 7509.36$, and $f = 1.4$. The foregoing factors have been computed either directly or from plotted values of a_1/A_1, a_2/A_1, etc., since it was desired to include

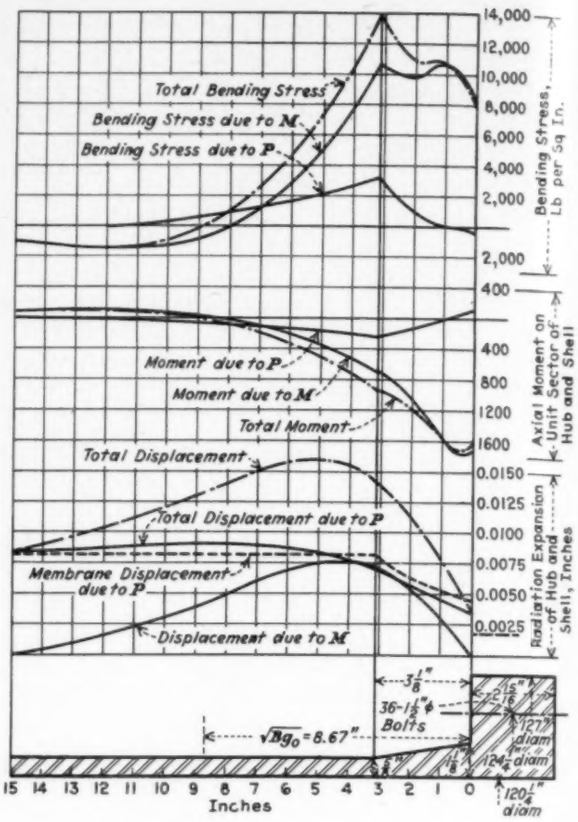

Total Bending Stress
Bending Stress due to M
Bending Stress due to P
Bending Stress, Lb per Sq In.
Moment due to P
Moment due to M
Total Moment
Axial Moment on Unit Sector of Hub and Shell
Total Displacement
Total Displacement due to P
Membrane Displacement due to P
Displacement due to M
Radial Expansion of Hub and Shell, Inches
36-1½" ϕ Bolts
√Bg₀ = 8.67"
Inches

Fig. 8—Graphical results of Examples 2 and 3

Progress in pressure vessel design and fabrication during the past two decades has brought about a marked change in the form of bolted connections. Whereas flanges were formerly provided with hubs of approximately uniform thickness, screwed to or slipped over the shell or pipe, it is now customary to use tapered hubs, and an integral structure is obtained by butt welding the end of the hub to the shell. This has invalidated former methods of design for flanged connections. . . . . This paper outlines a revised analysis based on the ring, tapered hub, and shell being considered as three elastically coupled units loaded by a bolting moment, a hydrostatic pressure, or a combination of the two. Design formulas and charts are given for the computation of stresses that are likely to be critical, and their application is illustrated by three problems which are taken from current commercial practice

a detailed analysis of hub stress in this and the following problem, for which accurate values of the design factors are essential. Stresses that may be critical are, in round numbers: S_H = 11,000 lb per sq in. (at small end of hub), S_R = 1600 lb per sq in., and S_T = 750 lb per sq in. It is quite obvious that in this particular flange the ring stresses are negligible.

Using the detailed stress analysis in the authors' complete report (8), the displacement, bending moment, and bending stress in the hub and shell have been computed for selected points, and the corresponding curves are shown in Fig. 8. These curves bring out clearly the stiffening effect of the tapered hub, the effect of the taper in shifting the maximum moment and bending stress away from the large end of the hub, and the small value of the shell as a strengthening element after a certain length has been reached. No curves are shown for the ring, since the ring stresses are not critical and the ring proportions are such that it rotates with practically no change of shape.

Example 3. The flange of example 2 is subjected to an internal pressure of 50 lb per sq in. Again using the formulas in the complete report, curves of displacement, moment and bending stress are shown in Fig. 8 for the effect of hydrostatic pressure with bolt pull absent. The dashed line indicates the membrane expansion of the three elements of the flange, treated as independent members without discontinuity stresses. The slope of the solid displacement curve at the junction of hub and ring illustrates the rotation of the ring due to hydrostatic pressure alone, in which respect the behavior differs markedly from that of a cylindrical vessel with reinforcing ring at a distance from its end. The moment at the large end of the hub is reduced, and the maximum occurs not at that point but at the second peak, where its sign reverses so that the bending stresses due to bolt pull and hydrostatic pressure are additive.

When the effects of bolt pull and internal pressure are combined, it is found that the latter adds considerably over 25 per cent to the bending stress caused by the former; thus, illustrating the importance of an investigation of pressure effects when the two components of bending stress have additive maxima. It should also be noted that the total expansion reaches a maximum of about 200 per cent of the membrane expansion alone. However, since the membrane hoop stress in the shell, figured by the customary simple rule, is somewhat less than 5000 lb per sq in., the actual maximum hoop stress is not excessive when compared with the maximum bending stress. Specifically, the total stresses at the junction of shell and hub are as follows, using Hooke's law for two dimensions:

Axial stress, outer surface = longitudinal membrane stress + bending stress = 16,575 lb per sq in.

Axial stress, inner surface = longitudinal membrane stress — bending stress = —11,765 lb per sq in.

Hoop stress, outer surface = (E × total hoop strain) + ν (axial stress in outer surface) = 12,068 lb per sq in.

Hoop stress, inner surface = (E × total hoop strain) + ν (axial stress in inner surface) = 3565 lb per sq in.

[*To be concluded*]

Welding Society Publishes Standard Welding Symbols

Realizing that welding cannot take its place as an engineering tool unless means are provided for conveying full information from designer to workmen, the *American Welding Society* has evolved and published a set of standard welding symbols covering both fusion and resistance welding.

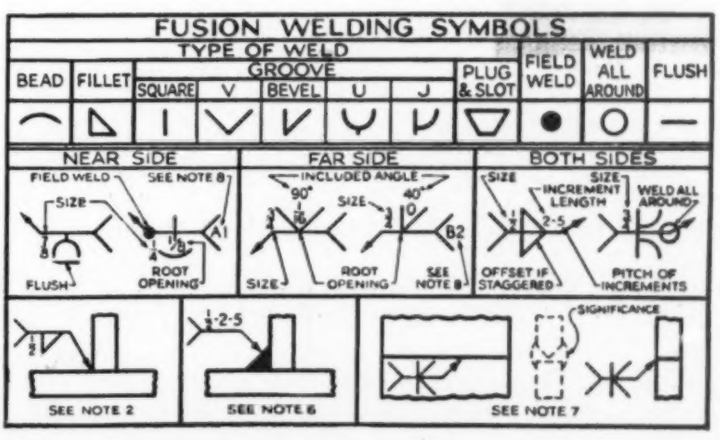
These symbols provide the means of placing complete welding information on drawings. They are ideographic; that is, they are picture-writing symbols, showing graphically the type of weld required. In evolving the symbols, the need for simplicity has been kept in mind and the general principle has been followed of having the most common form of any weld require a minimum of numerical data. In final form, the scheme amounts to a shorthand system whereby a large amount of information may be conveyed accurately with a few simple lines and numbers.

It is pointed out that, in practice, many companies may require only a few of the symbols, and if they desire, can make up their own legends, selecting such parts of the system as fit their needs and discarding the remainder. In such a case, where a weld departs from the user's standard, supplementary data will become necessary. But, this simply makes the user's standard a part of the symbol system and means only that exact interpretation will vary slightly among different users. On the whole the symbols lay the foundation for a universal welding language.

The symbols for fusion welding are reproduced here. A similar chart is available for resistance welding.

1. In plan or elevation, near, far and both sides locations refer to nearest member parallel to plane of drawing and not to others farther behind.
2. In section or end views only, when weld is not drawn the side to which arrow points is considered near side.
3. Welds on both sides are of same size unless otherwise shown.
4. Symbols govern to break in continuity of structure or to extent of hatching or dimension lines.
5. All welds are continuous and of user's standard proportions and all except V- and bevel grooved welds are closed unless otherwise shown.
6. When welds are drawn in section or end views, obvious information is not given by symbol.
7. In joints in which one member only is to be grooved arrows point to that member.
8. Tail of arrow used for specification reference.

Note: All dimensions are in inches.



Practical Standards for

Air Conditioning Calculations

Latent and Total Heat

By W. S. Bodinus*

LATENT heat is defined as the heat which is added to or extracted from a substance in changing its physical state from a solid to a liquid (latent heat of fusion) or from a liquid to a vapor (latent heat of vaporization). In air conditioning work the latent heat refers to the change of liquid water to water vapor in humidifying or the change of water vapor to liquid water in dehumidifying. The values of latent heat of evaporation in Btu per lb are, according to one authority:

Temperature, F	Latent Heat
32	1073.4
34	1072.3
36	1071.2
38	1070.2
40	1069.1
42	1068.0
44	1066.9
46	1065.8
48	1064.7
50	1063.6
52	1062.5
54	1061.4
56	1060.3
58	1059.3
60	1058.2
62	1057.1
64	1056.0
66	1054.9
68	1053.8
70	1052.7
72	1051.6
74	1050.6
76	1049.5
78	1048.4
80	1047.3
82	1046.2
84	1045.1
86	1044.0
88	1042.9
90	1041.8
94	1039.6
96	1038.5
98	1037.4
100	1036.3

The latent heat of fusion of ice is 144 Btu per lb of ice and if ice is used as the medium of cooling the quantity melted can be determined by using this value. Suppose 180,000 Btu per hr is to be absorbed, ice is to be used as the cooling medium, and that water at 52 F will satisfy the cooling requirements. The heat absorbing capacity of each pound of ice melted is:

1 lb ice × 144 ..... 144 Btu
1 lb water × (52 — 32) × 1 ..... 20 Btu

164 Btu

180,000 ÷ 164 = 1097 lb of ice melted per hr.

The ton of refrigeration per 24 hr is based upon the latent heat of fusion of ice and is defined as the heat absorbed by the melting of one ton of ice per day.

2,000 lb of ice × 144 = 288,000 Btu per day.

$$\frac{288{,}000}{24\text{ hr}} = 12{,}000 \text{ Btu per hr}$$

$$\frac{12{,}000}{60\text{ min}} = 200 \text{ Btu per minute}$$

Latent Heat Load in Air Conditioning

The latent heat load for air conditioning calculations is the sum of all items that produce water vapor. Such items as people, infiltration of outside air, coffee urns and certain products all give off water vapor which is latent heat. The quantity of water vapor given off per hour is measured in pounds or grains (7000 grains = 1 pound) and this quantity in pounds multiplied by the latent heat of vaporization (taken at the evaporating temperature) will give the heat quantity in Btu per hr. The average surface temperature of the human body is about 96 F, which is approximately 2½ F less than the normal internal temperature of 98.4 F. The latent heat of evaporation of water vapor at the surface temperature of 96 F is 1038.5 Btu per lb of water vapor. Thus, if the normal person at rest gives off 0.173 lb of water vapor per hr (equal to 1211 grains per hr) the amount of latent heat given off per person at rest is 0.173 lb × 1038.5 Btu = 179.65 Btu per hr, ordinarily used as 180 Btu per hr.

The latent heat as well as the sensible heat given up by persons varies with the amount of work being done by the person as shown in Table 4 of the *A.S.H.V.E. Guide*, 1937, p. 77.

The average hourly total heat per person in a theater, restaurant, or similar place, is taken as 400 Btu per hr, of which 180 Btu is latent heat and 220 Btu is sensible heat. These values are used where a temperature of 80 F dry bulb and 50 per cent relative humidity is maintained; if the conditions are 85 F dry bulb and 40 per cent relative humidity, the values are 220 Btu latent heat and 180 Btu sensible heat. If the conditions maintained are 75 F and 55 per cent, the values are 260 Btu sensible heat and 140 Btu latent. (See charts in *A.S.H.V.E. Guide*, 1937, p. 78).

The quantity of water vapor from infiltration of outside air is determined from the difference between the grains of moisture at the outside dewpoint and the room dewpoint. The latent heat value for water vapor is taken at the outside dewpoint temperature. If the infil-

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Part 4 of a series. Part 1 was published in the May issue, pp. 281-284, Part 2 in June, pp. 367-368, and Part 3 in July, pp. 415-417.

Properties of Saturated Water Vapor with Air

Temp., F	Pressure of Saturated Vapor		Weight of Saturated Vapor				Volume in Cu Ft Barometer, 29.92 In. Hg		Heat Content per Lb		
			per Cu Ft		per lb of Dry Air						
	In. of Hg	Lb per Sq In.	Pounds	Grains	Pounds	Grains	of 1 lb of Dry Air	of 1 lb of Dry Air + Vapor to Saturate it	Dry Air 0 F Datum	Vapor 32 F Datum	Dry Air with Vapor to Saturate it
0	0.03773	0 01853	0.000067914	0.475	0.0007852	5.50	11.58	11.59	0.0000	1059.2	0.8317
1	.03975	.01963	.000071395	.500	.0008275	5.79	11.60	11.62	.2401	1059.7	1.117
2	.04186	.02056	.000075021	.525	.0008714	6.10	11.63	11.64	.4801	1060.1	1.404
3	.04409	.02166	.000078851	.552	.0009179	6.43	11.65	11.67	.7201	1060.6	1.694
4	04645	02282	.000082890	580	0009671	6.77	11.68	11.70	.9601	1061.0	1.986
5	0 04886	0.02400	0.000087005	0 609	0.001017	7.12	11.70	11.72	1.200	1061.5	2.280
6	.05144	.02527	.000091399	.640	.001071	7.50	11.73	11.75	1.440	1061.9	2.577
7	.05412	.02658	.000095955	.672	.001127	7.89	11.75	11.77	1.680	1062.4	2.877
8	.05692	02796	.00010070	.705	.001186	8.30	11.78	11.80	1.920	1062.8	3.180
9	05988	02941	.00010572	740	.001247	8.73	11.80	11 83	2.160	1063.3	3.486
10	0.06295	0.03092	0.00011090	0.776	0.001311	9.18	11.83	11.85	2.400	1063.7	3.795
11	.06618	03251	.00011634	.814	001379	9.65	11.86	11.88	2.640	1064.2	4.108
12	.06958	03418	.00012206	.854	.001450	10.15	11.88	11.91	2.880	1064.6	4.424
13	.07809	.03590	.00012794	.896	.001523	10.66	11.91	11.93	3.120	1065.1	4.742
14	.07677	03771	.00013410	.939	.001600	11.20	11.93	11.96	3.359	1065.5	5.064
15	0 08067	0.03963	0.00014062	0.984	0 001682	11.77	11.96	11.99	3.599	1066.0	5.392
16	.08469	.04160	00014732	1.031	001766	12.36	11.98	12.01	3.839	1066.4	5.722
17	08895	.04369	00015440	1.081	001855	12.99	12.00	12.04	4.079	1066.9	6.058
18	.09337	.04586	.00016174	1 132	001947	13.63	12.03	12.07	4.319	1067.3	6.397
19	09797	.04812	.00016935	1 185	002043	14.30	12.06	12.09	4.559	1067.8	6.741
20	0.1028	0.05050	0.00017747	1.242	0 002144	15.01	12.08	12.12	4.798	1068.2	7.088
21	.1078	.05295	.00018564	1.299	.002250	15.75	12.11	12.15	5.038	1068.7	7.443
22	1132	.05560	.00019439	1.361	.002361	16.53	12.13	12.18	5.278	1069.1	7.802
23	.1186	.05826	.00020335	1.423	.002476	17.33	12.16	12.20	5.518	1069.6	8.166
24	.1244	.06111	.00021276	1 489	.002596	18.17	12.18	12.23	5.758	1070.0	8.536
25	0.1304	0.06405	0.00022255	1.558	0.002722	19.05	12.21	12.26	5.998	1070.5	8.912
26	.1366	.06710	.00023278	1.629	.002853	19.97	12.23	12.29	6.237	1070.9	9.292
27	.1432	.07034	.00024342	1.704	.002991	20.94	12.26	12.32	6.477	1071.4	9.682
28	1500	.07368	.00025445	1.781	.003133	21.93	12.28	12.34	6.717	1071.8	10.075
29	.1571	.07717	.00026597	1.862	.003283	22.99	12.31	12.37	6.957	1072.3	10.477
30	0.1645	0.08080	0.00027797	1 946	0.003439	24.07	12.33	12.40	7.197	1072.7	10.886
31	.1722	.08458	.00029043	2.033	.003601	25.21	12.36	12.43	7.437	1073.2	11.302
32	.1803	.08856	.00030343	2.124	.003771	26.40	12.38	12.46	7.677	1073.6	11.726
33	.1879	.09230	.00031471	2.203	.003931	27.52	12.41	12.49	7.917	1074.1	12.139
34	.1957	.09610	.00032690	2.288	.004094	28.66	12.43	12.51	8.157	1074.5	12.556
35	0.20360	0 1000	0.0003394	2.376	0.004262	29.83	12.46	12.54	8.397	1075.0	12.979
36	.21195	.1041	.0003527	2.469	.004438	31.07	12.48	12.57	8.636	1075.4	13.409
37	.22050	.1083	.0003682	2.563	.004618	32.33	12.51	12.60	8.876	1075.9	13.845
38	.22925	.1126	.0003799	2.660	.004803	33.62	12.53	12.63	9.116	1076.3	14.285
39	23842	1171	.0003943	2.760	.004996	34.97	12.56	12.66	9.356	1076.8	14.736
40	0 24778	0.1217	0.0004090	2.863	0.005194	36.36	12.59	12.69	9.596	1077.2	15.191
41	25755	1265	.0004243	2.970	.005401	37.80	12.61	12.72	9.836	1077.7	15.657
42	.26773	.1315	.0004401	3.081	.005616	39.31	12.64	12.75	10.08	1078.1	16.13
43	.27832	.1367	.0004566	3.196	.005840	40.88	12.66	12.78	10.32	1078.6	16.62
44	.28911	.1420	.0004735	3.315	.006069	42.48	12.69	12.81	10.56	1079.0	17.11
45	0.30031	0.1475	0.0004909	3.436	0.006306	44.14	12.71	12.84	10.80	1079.5	17.61
46	.31191	.1532	.0005088	3.562	.006553	45.87	12.74	12.87	11.04	1079.9	18.12
47	.32393	.1591	.0005274	3.692	.006808	47.66	12.76	12.90	11.28	1080.4	18.64
48	.33635	.1652	.0005465	3.826	.007072	49.50	12.79	12.93	11.52	1080.8	19.16
49	.34917	.1715	.0005663	3 964	.007345	51.42	12.81	12.96	11.76	1081.3	19.70
50	0.36241	0.1780	0.0005866	4.106	0.007626	53.38	12.84	12.99	12.00	1081.7	20.25
51	.37625	.1848	.0006078	4.255	.007921	55.45	12.86	13.02	12.23	1082.2	20.80
52	.39051	.1918	.0006296	4.407	.008226	57.58	12.89	13.06	12.47	1082.6	21.38
53	.40496	.1989	.0006516	4.561	.008534	59.74	12.91	13.09	12.71	1083.1	21.95
54	.42003	.2063	.0006746	4.722	.008856	61.99	12.94	13.12	12.95	1083.5	22.55
55	0.43570	0.2140	0.0006984	4.889	0.009192	64.34	12.96	13.15	13.19	1084.0	23.15
56	.45179	.2219	.0007228	5.060	.009536	66.75	12.99	13.19	13.43	1084.4	23.77
57	.46828	.2300	.0007477	5.234	.009890	69.23	13.01	13.22	13.67	1084.9	24.40
58	.48538	.2384	.0007735	5.415	.01026	71.82	13.04	13.25	13.91	1085.3	25.05
59	.50310	.2471	.0008003	5.602	.01064	74.48	13.06	13.29	14.15	1085.8	25.70
60	0.52142	0.2561	0.0008278	5.795	0.01103	77.21	13.09	13.32	14.39	1086.2	26.37
61	.54035	.2654	.0008562	5.993	.01144	80.08	13.11	13.35	14.63	1086.7	27.06
62	.55970	.2749	.0008852	6.196	.01186	83.02	13.14	13.39	14.87	1087.1	27.76
63	.57985	.2848	.0009153	6.407	.01229	86.03	13.16	13.42	15.11	1087.6	28.48
64	.60042	.2949	.0009460	6.622	.01274	89.18	13.19	13.46	15.35	1088.0	29.21
65	0.62179	0.3054	0.0009778	6.845	0.01320	92.40	13.21	13.49	15.59	1088.5	29.96
66	.64378	.3162	.0010105	7.074	.01368	95.76	13.24	13.53	15.83	1088.9	30.73
67	.66638	.3273	.0010440	7.308	.01417	99.19	13.26	13.57	16.07	1089.4	31.51
68	.68980	.3388	.0010816	7.571	.01468	102.8	13.29	13.60	16.31	1089.8	32.31
69	.71382	.3506	.0011140	7.798	.01520	106.4	13.31	13.64	16.55	1090.3	33.12
70	0.73856	0.3628	0.0011507	8.055	0.01574	110.2	13.34	13.68	16.79	1090.7	33.96
71	.76431	.3754	.0011884	8.319	.01631	114.2	13.37	13.71	17.03	1091.2	34.83
72	.79058	.3883	.0012269	8.588	.01688	118.2	13.40	13.75	17.27	1091.6	35.70
73	.81766	.4016	.0012667	8.867	.01748	122.4	13.42	13.79	17.51	1092.1	36.60
74	.84555	.4153	.0013075	9.153	.01809	126.6	13.44	13.83	17.75	1092.5	37.51
75	0.87448	0.4295	0.0013497	9.448	0.01873	131.1	13.47	13.87	17.99	1093.0	38.46
76	.90398	.4440	.0013927	9.749	.01938	135.7	13.49	13.91	18.23	1093.4	39.42
77	.93452	.4590	.0014371	10.06	.02005	140.4	13.52	13.95	18.47	1093.9	40.40
78	.96588	.4744	.0014825	10.38	.02075	145.3	13.54	13.99	18.71	1094.3	41.42
79	.99825	.4903	.0015295	10.71	.02147	150.3	13.57	14.03	18.95	1094.8	42.46
80	1.0316	0.5067	0.0015777	11.04	0.02221	155.5	13.59	14.06	19.19	1095.2	43.51
81	1.0661	.5236	.0016273	11.39	.02298	160.9	13.62	14.12	19.43	1095.7	44.61
82	1.1013	.5409	.0016781	11.75	.02377	166.4	13.64	14.16	19.67	1096.1	45.72
83	1.1377	.5588	.0017304	12.11	.02459	172.1	13.67	14.21	19.91	1096.6	46.88
84	1.1752	.5772	.0017841	12.49	.02543	178.0	13.69	14.26	20.15	1097.0	48.05
85	1.2135	0.5960	0.0018389	12.87	0.02629	184.0	13.72	14.30	20.39	1097.5	49.24
86	1.2527	.6153	.0018950	13.27	.02718	190.3	13.74	14.34	20.63	1097.9	50.47
87	1.2933	.6352	.0019531	13.67	.02810	196.7	13.77	14.39	20.87	1098.4	51.74
88	1.3346	.6555	.0020116	14.08	.02904	203.3	13.79	14.44	21.11	1098.8	53.02
89	1.3774	.6765	.0020725	14.51	.03002	210.1	13.82	14.48	21.35	1099.3	54.35
90	1.4211	0.6980	0.0021344	14.94	0.03102	217.1	13.84	14.53	21.59	1099.7	55.70
91	1.4661	7201	.0021982	15.39	.03205	224.4	13.87	14.58	21.83	1100.2	57.09
92	1.5125	.7429	.0022634	15.84	.03312	231.8	13.89	14.63	22.07	1100.6	58.52
93	1.5600	.7662	.0023304	16.31	.03421	239.5	13.92	14.69	22.32	1101.1	59.99
94	1 6088	7902	.0023992	16 79	.03535	247.5	13.94	14.73	22.56	1101.5	61.50
95	1.6591	0.8149	0.0024697	17.28	0.03652	255.6	13.97	14.79	22.80	1102.0	63.05
96	1.7108	.8403	.0025425	17.80	.03772	264.0	13.99	14.84	23.04	1102.4	64.62
97	1.7638	.8663	.0026164	18.31	.03896	272.7	14.02	14.90	23.28	1102.9	66.25
98	1.8181	.8930	.0026925	18.85	.04024	281.7	14.04	14.95	23.52	1103.3	67.92
99	1.8741	9205	.0027700	19.39	.04156	290.9	14.07	15.01	23.76	1103.8	69.63
100	1.9316	0.9487	0.0028506	19.95	0.04293	300.5	14.10	15.07	24.00	1104.2	71.40
101	1 9904	.9776	.0029316	20.52	.04433	310.3	14.12	15.12	24.24	1104.7	73.21
102	2.0507	1.0072	.0030156	21.11	.04577	320.4	14.15	15.18	24.48	1105.1	75.06
103	2.1128	1.0377	.0031017	21.71	.04726	330.8	14.17	15.25	24.72	1105.6	76.97
104	2.1763	1.0689	.0031887	22.32	.04879	341.5	14.20	15.31	24.96	1106.0	78.92

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tration of air is 10 lb per minute at an outside dewpoint of 67 F into a room at a dewpoint of 60 F, the water vapor added to the room is as follows:

Grains of water vapor per lb of air at 67 F D.P. = 99.19
Grains of water vapor per lb of air at 60 F D.P. = 77.21

Difference 21.98

10 lb of air × 21.98 = 219.8 grains per minute.
Latent heat of evaporation at 67 F = 1054.3 Btu per lb.

$$\frac{219.8 \times 60}{7000} = 1.88 \text{ lb of water vapor per hr.}$$

1.88 × 1054.3 = 1982 Btu per hr latent heat due to infiltration.

The quantity of water vapor given off from products that might be drying in the room or from plants or objects saturated with water must be determined and this quantity multiplied by the latent heat at the room wet bulb. If for instance the room is at a temperature of 80 F dry bulb, 67 F wet bulb and 60 F dewpoint, and an object in the room gives up 2 lb of water vapor per hr, the quantity of latent heat liberated per hour is:

Latent heat at 67 F = 1054.3 Btu per lb
2 lb × 1054.3 = 2108.6 Btu

The quantity of water vapor (latent heat) given up in a space is more difficult to establish accurately than is the sensible heat load. The items producing water vapor (people, infiltration and that given up from products) generally are quite variable. The total sum of water vapor once established is converted from water vapor to heat by using an average value of 1040 Btu per lb of water vapor. Thus if the amount of water vapor is 50 lb per hr the latent heat load would be 50 × 1040 = 52,000 Btu per hr.

Inversely, if the calculations were made using tabulated latent heat values in Btu per hr and the total latent is 52,000 Btu per hr, the amount of water vapor would be 52,000 ÷ 1040 = 50 lb per hr, and 50 × 7000 = 350,000 grains per hr.

A crowded basement in a department store. Such spaces have a high latent heat load

Air Required to Pick Up Latent Heat

Since air is the medium of absorbing latent heat (moisture pick up) it is necessary to put the air in a condition to be able to absorb moisture. This is accomplished similarly to the absorption of sensible heat in that the absolute humidity (dewpoint) is reduced sufficiently to make the air capable of taking on moisture. As previously explained, the pick up of sensible heat in a conditioned room is accomplished by the quantity of air circulated at a reduced dry bulb temperature. The pick up of latent heat is accomplished by the same air circulated at a reduced entering dewpoint temperature. Thus if we circulate 9333 cfm to pick up 150,000 Btu sensible heat, this same quantity of air can have its dewpoint reduced sufficiently to accomplish the latent heat pick up. If the latent heat load is 52,000 Btu, this is equal to

$$\frac{52{,}000 \text{ Btu per hr}}{1040 \text{ Btu per lb}} = 50 \text{ lb of water vapor per hr}$$

50 lb × 7000 grains = 350,000 grains per hr

The quantity of water vapor to be picked up per cu ft of air circulated is:

$$\frac{350{,}000 \text{ grains per hr}}{60 \text{ min} \times 9333 \text{ cfm}} = 0.625 \text{ grains per cu ft}$$

If the average room conditions are to be 80 F dry bulb and 50 per cent relative humidity, the dewpoint temperature is 59.5 F and the air contains 75.85 grains per lb or 5.699 grains per cu ft of air. Since this air is required to pick up 0.625 grains per cu ft, the air must be supplied to the room at a condition of (5.699 — 0.625) or 5.074 grains per cu ft. Referring to the table of properties of air we find that 5.074 grains per cu ft cor-

responds to approximately 56 F dewpoint (5.06 grains per cu ft). Thus the dewpoint of the air entering the room must be not higher than 56 F, or 3½ F lower than the expected room dewpoint in order to maintain the conditions established of 80 F dry bulb and 50 per cent relative humidity.

Since the calculations are based on maintaining an average air condition in the room, the return air is probably the best indication of the average conditions so in most cases the thermostats and hygrostats are placed in the return air duct or near the return air grille. This is especially true where a number of rooms are connected to one air conditioning apparatus. As previously explained, the pick up of sensible heat in a conditioned room is accomplished by the quantity of air circulated at a reduced dry bulb temperature and the pick up of latent heat is accomplished by the same air circulated at a reduced entering dewpoint temperature. In the illustrations set forth a sensible heat load of 150,000 Btu per hr required the circulation of 9333 cfm of air at a dry bulb temperature 15 F lower than the room (80 F room dry bulb temperature — 15 F) = 65 F dry bulb entering air temperature. The latent heat load of 52,000 Btu per hr (50 lb of water per hr) is absorbed by this same 9333 cu ft of air at a dewpoint temperature 3½ F lower than the room dewpoint (59.5 F room dewpoint temperature —3½ F) = 56 F entering dewpoint temperature.

The Total Heat Load

For air conditioning calculations, total heat is defined as the sum of all of the sensible heat loads and all of the latent heat loads, and is known as the room total heat. The room total heat does not establish the refrigeration load since it does not include the cooling load of outside air. The room total heat does, however, give us an easy means of establishing the dewpoint of the air entering the conditioned space. The amount of sensible heat absorbed or given up by an object is determined by use of the formula

$$\text{Sensible Btu} = W \times (T_2 - T_1) \times C$$

where W = weight in pounds

$T_2 - T_1$ = temperature differential

C = specific heat

Since the wet bulb temperature determines the total heat in air, the total heat absorbed (sensible plus latent) by a quantity of air is measured by the difference between the respective wet bulb temperatures. If H_1 equals the total heat at the wet bulb temperature of the air entering a space and H_2 at the wet bulb temperature of the air leaving the space, the total heat picked up in Btu per lb (W) of air is

$$\text{Total heat, Btu} = W(H_2 - H_1)$$

If the sensible heat formula is divided by the total heat formula, the following relation exists

$$\frac{\text{Sensible heat Btu}}{\text{Total heat, Btu}} = \frac{W \times (T_2 - T_1) \times C}{W \times (H_2 - H_1)}$$

C = 0.24, specific heat of air

H_s = sensible heat, Btu

H_t = total heat, Btu

$$\frac{H_s}{H_t} = \frac{W \times (T_2 - T_1) \times 0.24}{W \times (H_2 - H_1)}$$

In the previous examples the room condition was taken as 80 F dry bulb, 50 per cent relative humidity, 59.5 F dewpoint, and 66.7 F wet bulb. H_s = 150,000 Btu per hr, H_L = latent heat = 52,000 Btu.

$$H_t = H_s + H_L$$

H_t = 150,000 Btu per hr + 52,000 Btu per hr = 202,000 Btu per hr

The dry bulb temperature differential was taken as 15 F, *i. e.*, $(T_2 - T_1) = (80 - 65) = 15$ F, and the total heat (H_2) corresponding to the room wet bulb of 66.7 F is 31.276 Btu per lb.

Substituting values in the formula:

$$\frac{H_s}{H_t} = \frac{W \times (T_2 - T_1) \times 0.24}{W \times (H_2 - H_1)}$$

$$\frac{150{,}000}{202{,}000} = \frac{15 \times 0.24}{(31.276 - H_1)}$$

$$0.7426 = \frac{3.6}{(31.276 - H_1)}$$

$$23.226 - 0.7426\,H_1 = 3.6$$

$$-0.7426\,H_1 = -19.626$$

$$H_1 = \frac{19.62}{0.7426} = 26.42 \text{ Btu per lb}$$

By referring to the table of properties of air, 26.42 Btu per lb is seen to correspond to a wet bulb temperature of approximately 60 F. Thus the temperature of the air entering the conditioned area is 65 F dry bulb and 60 F wet bulb, which by referring to a psychrometric chart, gives a dewpoint of 57 F and a relative humidity of 75 per cent. Thus we have an easy method of determining the entering room dewpoint which will necessarily vary with the quantity of air circulated.

A line drawn on the psych chart published last month, through the room conditions and the air entering conditions and extended through the saturation curve will give a locus of all dewpoints for any given dry bulb differential. If this is done for the above example (*i. e.*, draw line from the point at 80 F dry bulb and 50 per cent relative humidity through 65 F dry bulb and 75 per cent relative humidity, and extend through saturation line at approximately 52 F) the lowest dewpoint of air entering the conditioned space would be 52 F. Any lower dewpoint would cause a lower relative humidity in the room, which ordinarily is not objectionable unless it drops too low and the space then feels uncomfortably cool.

[*To be continued*]

Apartment Building—

[*Concluded from p.* 484]

call whenever he wants the tank filled. Ice is delivered in 100 lb bags and is brought in through the service entrance to the kitchen so that no inconvenience or dirt is involved.

The ice tank of course has an overflow and a drain plug as shown in the diagram, and the condensation, or drainage, is to a stack. These units are compact and in order to conserve space, always of prime importance in apartments, are placed under the kitchen sinks where they are properly sealed against air leakage. The air ducts are built into the walls, and are made of sheet metal covered with air cell asbestos paper.

Practically all of the apartments were rented by the time the building was completed. Cost of building and installing the cooling units was about $150 per suite.

New Data for

Refrigeration Piping Design

By R. C. Doremus*

In this article and others to follow, the author presents basic data on the design and installation of piping for industrial and commercial refrigeration work and air conditioning. As a refrigeration engineer, Mr. Doremus has had the opportunity to observe jobs which have been poorly designed, has concluded that lack of available information is the cause. He therefore makes available his tables and charts in this form . . . Special attention is to be given to the newer refrigerants in these articles

IT is the purpose of this article to give some data which may assist the designer in becoming more familiar with the behavior characteristics of the refrigerant, "Freon-12" ("F-12" for short). Stress will be laid especially on piping rather than machine design in order to be of benefit to the majority of designers of plant installations.

It is presumed that the designer is quite familiar with his refrigeration problem—what is to be cooled, the rate of cooling, the temperature drop, the desirable refrigerant temperature and corresponding suction pressure and the computations necessary in estimating the magnitude of the load in tons of refrigeration. It is naturally essential that an evaporator and compressor of suitable capacity and balance be chosen to handle the load but it is more vital to the correct design and operation of this equipment that the piping for liquid and suction lines between the evaporator and compressor be properly planned and installed. A compressor may be chosen that is furnished by the manufacturer with a 1 in. liquid and a 2 in. suction connection to operate with several evaporators each furnished with ¾ in. liquid and 1½ in. suction connections.

Of what sizes are the liquid and suction line pipes to be chosen and how arranged? Obviously, the manufacturer of either coils or compressors must design his equipment to operate at various conditions of suction pressure for evaporation temperatures from 40 F below zero to 40 F above zero and for these universal adaptations one standard size of service suction valve and liquid line valve is incorporated in his design. The suction vapor handled at minus 40 F is approximately 30,000 cu in. per min per ton while at plus 40 F it is approximately 5,000 cu in. per min per ton or a ratio of six to one over this range.

Naturally any attempt to equalize equipment pipe connection sizes is dangerous so far as velocities are concerned and often is impossible. It is therefore preferable to design the piping on a basis of velocity and pressure drop for any problem, inasmuch as these functions determine the balance between initial capital investment or first cost and power and maintenance, which so strongly affect ultimate cost. Also, no two plants will be exactly alike where precedence might govern for they will usually vary in capacity, expanse or static height so that each layout must be designed on its own merits to meet its own peculiar requirements.

Piping Materials

"Freon" has no chemical effect on iron, steel, aluminum, brass, bronze or copper and consequently any of these metals as preferred may be used in the equipment or piping. It seems to have an abnormal ability to escape from a system that is apparently leak tight and will even diffuse to some extent through a cast fitting or compressor crankcase in case the metal is coarse grained or too thin. Therefore extreme care must be exercised in all joints and as with the other refrigerants, it is good practice to design the piping as short, direct and straight as possible with a minimum of joints and then make up these joints very carefully. If steel piping is used, it should be new and clean of rust or scale with all joints welded. Copper is used in most cases with streamline fittings and in some cities, the code calls for forged brass fittings rather than cast and 95 per cent solder instead of 50/50 sweat soldered with 1050 F temperature instead of 400 F, which is a precautionary step in the right direction.

Liquid Line Piping

"Freon-12" liquid is quite heavy compared with water or ammonia and has a density of 90 lb per cu ft at 5 F and 80.6 lb per cu ft at 86 F. Inasmuch as the refrigerating effect is comparatively low, *viz.* 44—54 Btu per lb, relatively large volumes are circulated which range from 4½ to 3¾ lb per min per ton from —40 F to plus 40 F. The liquid is more viscous and about 40 per cent heavier than water which means that relatively large liquid lines are necessary to avoid a large friction drop through the liquid line between the liquid receiver and evaporators. In order to avoid excessive drops, it is recommended that liquid lines be proportioned so that the liquid velocity will be not over 4 ft per sec or as indicated by Table 1.

Table 1—Recommended "Freon-12" Liquid Line Sizes for Various Tonnages

Tonnage	Size Liquid Line, In.
0-1	¾
1-3	⅞
3-5	⅞
5-12	1⅛
12-20	1⅛
20-40	1⅜
40-75	1⅝
75-100	2⅛
100-150	2⅝
150-200	3⅛
200-300	3⅝
300-400	4⅛
400-600	5⅛

*Detroit Ice Machine Co. Member of Board of Consulting and Contributing Editors.

FIG. 1
PRESSURE DROP VS. CAPACITY FOR LIQUID FREON-12 THROUGH THERMAL EXPANSION VALVES

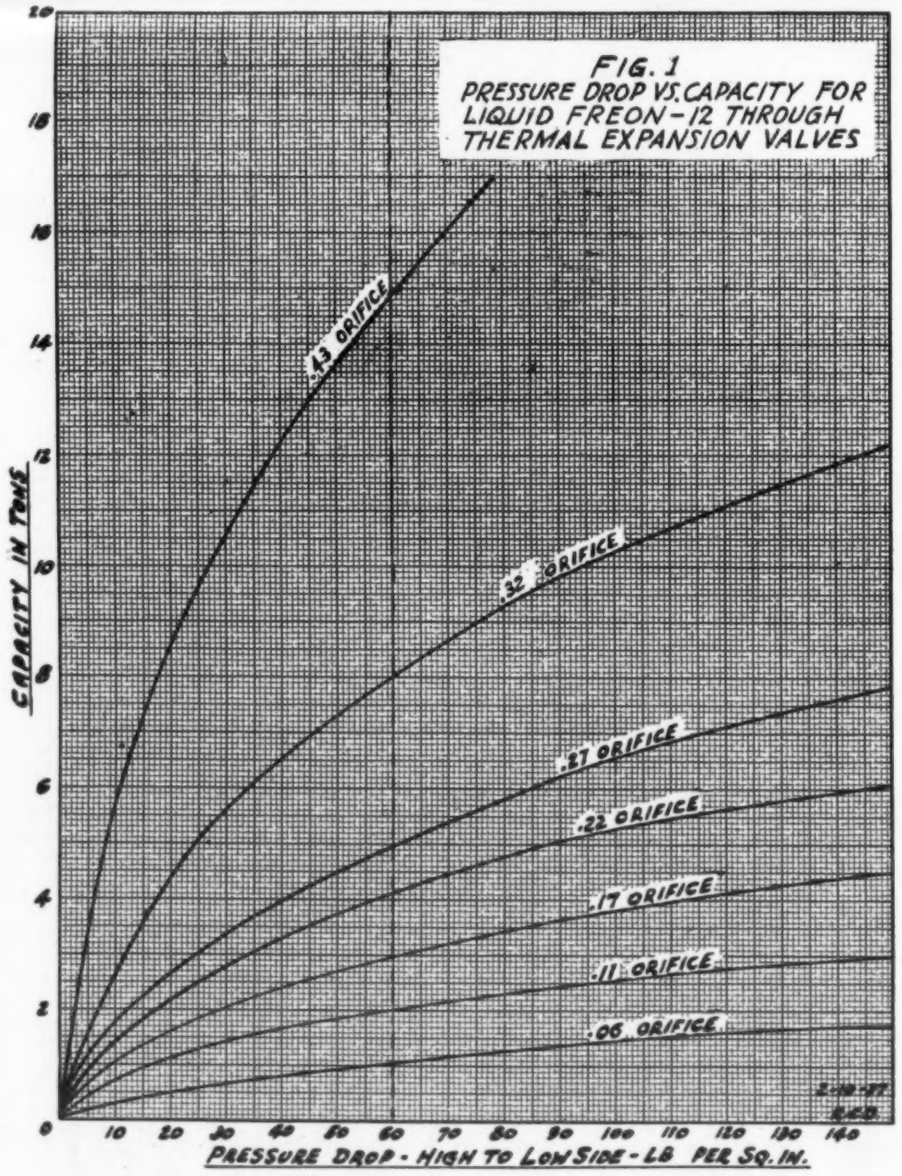
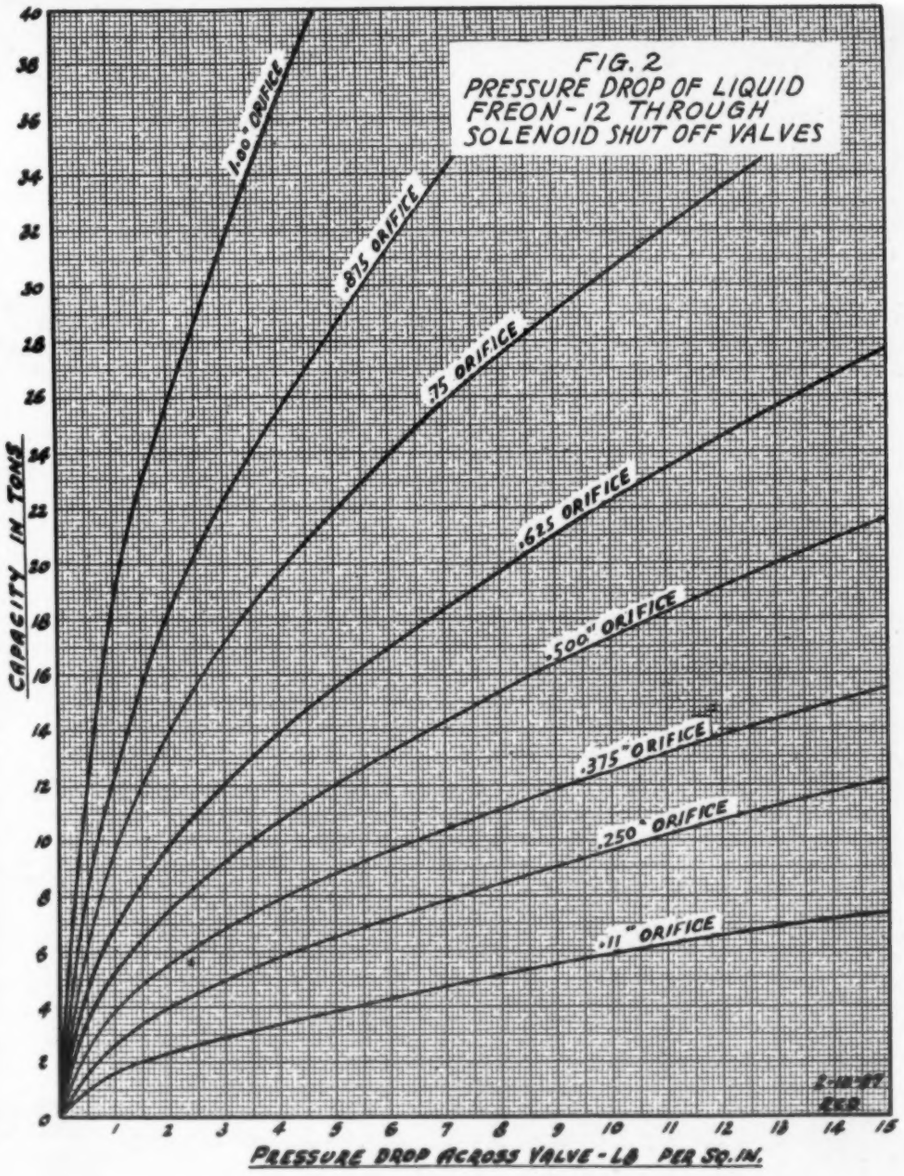

CAPACITY IN TONS
.43 ORIFICE
.32 ORIFICE
.27 ORIFICE
.22 ORIFICE
.17 ORIFICE
.11 ORIFICE
.06 ORIFICE
0 2 4 6 8 10 12 14 16 18 20
10 20 30 40 50 60 70 80 90 100 110 120 130 140
PRESSURE DROP - HIGH TO LOW SIDE - LB PER SQ. IN.

FIG. 2
PRESSURE DROP OF LIQUID FREON-12 THROUGH SOLENOID SHUT OFF VALVES


CAPACITY IN TONS
1.00" ORIFICE
.875 ORIFICE
.75 ORIFICE
.625 ORIFICE
.500" ORIFICE
.375" ORIFICE
.250" ORIFICE
.11" ORIFICE
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
PRESSURE DROP ACROSS VALVE - LB PER SQ. IN.

Due to the heavy weight of "Freon" liquid, as compared with ammonia for example, the pressure in a liquid riser will decrease quite rapidly; in fact, twice as fast. Therefore, in multi-story plants where the evaporators and expansion valves are several floors above the receiver, this drop in pressure must receive careful consideration in the choice of size of orifice for the expansion valve in order that the resultant pressure differential across the valve will pass a sufficient amount of liquid to satisfy the tonnage demand.

This may be illustrated as follows:—If we assume we have liquid "Freon" leaving the receiver at 120 lb pressure to be raised in a liquid riser a height of 60 ft, the drop in pressure between receiver and expansion valve will be approximately 33 lb, leaving a pressure of 87 lb ahead of the expansion valve instead of 120 lb. If the evaporator is to operate at 40 lb pressure the differential or drop across the valve is only—

87 — 40 = 47 lb drop on 4th floor as against—

120 — 40 = 80 lb drop in basement,

Thus if the evaporator is located on the 4th floor and has a 5½ ton load of refrigeration to perform, the valve must have an orifice of 0.32 in. diameter for 47 lb differential whereas a smaller valve of say 0.27 in. diameter orifice would be sufficient if the evaporator were in the basement with an 80 lb differential (See Fig. 1).

It is common practice to choose valve sizes based on no greater than 60 lb differential for air conditioning installations inasmuch as cooler condensing water in winter time may give very low condensing pressures while the evaporator pressure will remain constant.

This is further aggravated by the fact that as the pressure drops in rising in this liquid line riser, some of the liquid boils off and we have a mixture of liquid and gas to be handled through the valve. In this case the liquid would occupy a space of 0.047 cu ft per ton of refrigeration and the gas produced by the drop in pressure would be about 0.036 cu ft per ton of refrigeration or a volume 75 per cent as much as the liquid. For this reason the liquid riser and expansion valve should be ample to pass both liquid and gas and the choice of too small a size of either pipe or valve will cause an excessive throttling or bottle neck which may result in diminished capacity through no fault of the evaporator or compressor.

In some cases where the layout and local refrigeration code will permit, the compressor may be situated in a basement with the condenser on the top floor or penthouse and the liquid line run down from the roof to evaporators and valves situated on floors below the roof. In this layout, the liquid pressure naturally increases in dropping in the liquid riser instead of decreasing and smaller instead of larger valves may be used for a given capacity load.

This layout has the disadvantage of a rather long discharge gas line from compressor to condenser but avoids the necessity of pumping liquid to upper floors or of splitting the building up into several multiple systems where many floors are to be served. This high condenser location requires more supply and waste water piping than when located in the basement but becomes advantageous when the water is recirculated and cooled by a spray tower or pond on the building roof when its high location becomes ideal from a standpoint of water pumping head.

Fig. 2 shows the pressure drop in liquid "Freon" through solenoid liquid shutoff valves of one popular make. Other makes may vary from these figures slightly, but the designer should get data from the manufacturer if he is in doubt. In any event, this chart will serve satisfactorily as a general rule for design.

Emphasis should be laid on the importance of choosing a solenoid valve of a large enough orifice so that the pressure drop across the valve will not be excessive or prohibitive and this is especially important in the case of the 4th floor evaporator mentioned above, where too small a solenoid valve with a relatively large pressure drop might cause a bottle neck and require an extremely large expansion valve which, of course, is neither to be desired from a standpoint of good design or economy. The effect of too small a solenoid shutoff valve is threefold: (1) It reduces the available differential pressure drop across the expansion valve; (2) it causes such a reduction in pressure ahead of the expansion valve that a certain amount of gas is formed; and (3) both of these faults accumulatively reduce capacity or require too large an expansion valve to correct the defect.

Lubrication

Inasmuch as "Freon—12" and the mineral oils used are miscible, the liquid "Freon—12" is not "pure quill" but contains a certain amount of oil according to the temperature and viscosity of the oil. It is possible for the percentage of oil to be rather high which means that the piping and valves are feeding a mixture or solution of "Freon—12" and oil and for this reason also the liquid lines must be generously large as indicated. In the case of ammonia, we do not have this to contend with inasmuch as the oil is heavy and is immiscible and hence settles out readily. Therefore, it is important to avoid traps in the liquid and suction piping and evaporators in order to prevent a collection of oil in the piping system with a resulting decrease of oil in the compressor crankcase which would cause the compressor to run low or dry of oil.

Oil Recovery

To illustrate this miscibility of "Freon—12" and oil let us consider an oil having a viscosity of 150-160 and a pour test of —40 F. In the evaporator at 40 lb pressure and 60 F temperature, this oil can contain 45 per cent of "Freon" liquid as a stable solution. As this returns to the compressor crankcase, it may have a suction pressure of 20 lb in the case under which condition it can contain only 22 per cent of liquid. This means that with a sudden drop in pressure or liquid slugging back in the suction line, a considerable amount of gas is liberated which will froth the oil and cause the compressor to pump oil, which is a dangerous condition mechanically. This emphasizes the need of good oil recovery in planning the layout. Incidentally, this thinning of the oil in the crankcase permits the use of a higher viscosity oil for "Freon" than would be considered desirable with ammonia.

On the high side, let us suppose the condensing pressure is 100 lb at 90 F. The oil under this condition can

hold 85 per cent of "Freon" by weight. If the pressure is higher, say 120 lb at 100 F, the oil can hold as high as 95 per cent of "Freon—12" by weight. Obviously, the oil will not separate from the "Freon" in the receiver but will separate to a great extent when the pressure and temperature are decreased, as in the evaporator. On account of this tendency, the liquid connection to a direct expansion "Freon" evaporator must be made at the top and the suction at the bottom and the suction line preferably run downward from the evaporator to the compressor to drain the oil back to the crankcase. In some cases the suction line must run upward to the compressor. In this type of layout, an oil leg should be used at the evaporator suction connection to pick up the oil in the return gas and the gas velocity maintained at 1000 fpm or higher which will cause the oil to climb in the suction riser, as ripples along the inside wall of the suction pipe.

In simple systems involving one compressor and one evaporator, it is common practice not to use an oil separator in the discharge line to drain back oil to the compressor crankcase, as long as the piping connections are short and the evaporator is of the direct expansion type with liquid feed in the top and suction out at the bottom. In larger multiple systems or those involving liquid coolers or flooded evaporators that can trap oil, it is necessary to use oil separators in the discharge line and some means of recovering the oil from the evaporator either manually or automatically. The flooded type evaporator is a natural oil trap for it is here that the greatest degree of oil separation will occur of any point on the system. Therefore a positive means of oil recovery is necessary. One patented method in popular use is by a thermal valve drain into a coil or heat exchanger with a gravity drain from the low point of the evaporator into the suction line. This means however, is usually confined to the larger tonnage plants where relatively large amounts of liquid "Freon" and oil are concerned.

In all instances, it is essential to recover the oil to the crankcase of the compressor but it is especially important in the smaller machines of ½ to 15 hp sizes inasmuch as their crankcases are extremely small and a loss of even a small amount of oil is accentuated.

[This is the first of several articles by Mr. Doremus on refrigeration piping. The next will discuss suction line piping and will include numerous tables and charts, including charts showing pressure drop in "Freon-12" suction lines of various diameters per 100 ft of length.]

Ventilating and Heating Store Windows

THE following remarks were prepared in answer to a recent request from a reader of H. P. & A. C. for information on the ventilating and heating requirements of show windows. The editors will welcome contributions from others who have had experience with this type of work, and those which are published will be paid for at regular rates:

I have no recollection of seeing any comprehensive treatment of the problem of heating and ventilating show windows. Presumably the reader is interested in the prevention of over-heating in the summer and of condensation and frosting in the winter. Both of these objectives can be attained without very close regulation of temperatures.

Conditions in a closed show window vary between wide extremes daily. The source of artificial light liberates heat in proportion to the intensity of illumination. This heat is in most cases augmented by the radiant energy of the sun during at least a part of the day. At night both these sources of heat are withdrawn and the temperature inside the window drops to an extent depending principally upon the outside temperature. The drop is retarded to a small extent by transfer between the show window and the inside of the store. So far as I can see, only enough heat is required to prevent condensation—that is, enough to keep the inside surface of the glass above the dewpoint. Fortunately, in winter the natural dewpoint is low and it is seldom raised very high inside of buildings by artificial means. With a temperature of 75 F and a relative humidity of 35 per cent the dewpoint would be 45 F. There is hardly anything which would be damaged by this temperature in a display window.

Around Boston, of late years, frosting of windows has been less noticeable, I think. I ascribe this to the use of higher intensities of illumination to counteract reflections, with the consequent liberation of more heat. The warming of the floor and merchandise by radiant energy reflected downward by silvered reflectors and the heat at the lights themselves induce convection currents which keep the glass heated above the dewpoint. The paper by Sturrock and Walker on heating effect of artificial lighting is of pertinent interest.[1]

Where extremely low temperatures prevail, it is obvious that other means of heating must be installed. The simplest device would be a steam pipe along the floor at the bottom of the glass. A more expensive but better method would be to deliver heated and filtered air through a duct, with outlets spaced closely along the base of the glass. The minimum quantity of air should be used, as large volumes would cause movement of articles like garments. It should be noted that in a newly plastered building the air will be abnormally humid for a time and it may not be possible to prevent condensation entirely until the plaster is dry.

At the other extreme are the very high summer temperatures. When lighting intensities were low, the heat was not enough to cause concern; but it must be recognized now that positive removal of the heat is essential. I am familiar with a case of this kind—a corner window of about 280 sq ft, with 14,400 watts or about 50 watts per sq ft of floor space. The total heat gain, including sun load, was about 50,000 Btu per hr—enough to convert over five gallons of water into steam at 212 F every hour. Assuming 100 F as the desired maximum temperature in the window and knowing the temperature of the replacement air, it was a simple matter to compute the volume to be exhausted to remove the excess heat.—RICHARD BRUNEL.*

*Construction Engineer, Wm. Filene's Sons Co.

[1] *A.S.H.V.E. Journal Section*, HEATING, PIPING AND AIR CONDITIONING, November, 1933, pp. 581-589.

E. Vernon Hill's* Personal Comments

The Human Hand

ANATOMICALLY, the human hand is a prehensile organ consisting of twenty-six articulated bones, about forty-five separate and distinct muscles, and supplied with a large network of blood vessels and nerves.

The human hand is a truly marvelous organ, and the progress of civilization can be attributed largely to man's development and training of his hands.

Thomas Carlyle, long ago directed attention to this fact. "Man is a tool using animal," he said, and it is this fact primarily that distinguishes him and lifts him above the rest of the animal creation—and both the fabrication and use of tools awaited the educated hand.

Herman, the magician, trained his hands by long hours of tedious practice to accomplish the seemingly impossible. A playing card or a coin he made to wander over and under his hand and between his fingers, finally to disappear without apparent movement of his fingers. It seemed to the audience that the card or coin was alive and intelligent, the hand dead and motionless. "The hand is quicker than the eye" was an expression that developed during this great magician's popularity.

Paderewski, the great Polish pianist, educated his hands in a somewhat different manner, and to a still more difficult technique. Muscle training equal at least to the magician's was required, and in addition a coordination in timing that made it possible for him to tumble out of his piano, the notes of a Liszt rhapsody at the rate of a hundred per second, each in perfect time, quality and magnitude.

But hands have nerves of touch as well as muscles and these can also be developed and trained.

Helen Keller came into the world shut out from the world. She was born deaf, dumb and blind—but with an active brain and an indomitable will. She trained the sensory nerves of her fingers, developed the tactile sense, so that she could tell by the merest touch of her fingertips more about the nature and quality of a fabric than could the average person by the most careful visual examination. With the aid of the Braille system of reading, she became an exceptionally well educated woman. The best in art, science and literature from the world's storehouse of knowledge flowed to her receptive brain through her educated fingertips.

But the hands are provided with a wonderful blood supply as well as with muscles and nerves. So dense is the capillary network in the skin that no pin point, be it ever so sharp, is fine enough to puncture the skin without drawing a crimson drop to the surface. The blood flow to the skin, primarily intended to supply nourishment and warmth and remove the waste products of muscular activity, it now develops has an additional function of great importance.

Dr. Charles Sheard, director of the division of physics and biophysical research of the Mayo Foundation, related to the engineers gathered at St. Louis last January some interesting developments in his research work at Rochester on the skin temperature of the hands under various conditions.

It has been observed by other investigators that the temperature of the hands and feet varies over a much wider range than does that of other body surfaces. The writer has seen the temperature of the fingers rise 9 F in a few minutes while the subject smoked a cigarette, the temperature and humidity of the room remaining constant. Dr. Sheard has noted a temperature rise of 25 F of fingers in a period of two hours after the subject has taken food. Even with the subject quiet, without food or other disturbing influences, in a room where the temperature and humidity are constant, the skin temperature of the fingers wanders back and forth over a range of 8 or 10 F while the skin temperature of the head and trunk varies only a degree or so, if at all.

The obvious conclusion, Dr. Sheard points out, is that the hands and feet, particularly the hands, are the principal temperature controlling organs of the body. The relatively large surface of the hands and wrists makes them, like small radiators, well adapted to so function, forming also, as they do, about 70 per cent of the exposed surface when the body is clothed.

An interesting sidelight on this new conception of our comfort mechanism is the fact that we are not conscious of comparatively wide variations in the skin temperature of our hands; our friends tell us that our hands are hot or cold before we realize it ourselves. This fact explains why the comfort zone on a psychrometric chart is so broad and its boundaries so indeterminate.

Engineers have long felt that the medical profession has underestimated the importance of our air environment as it affects comfort and health, and doctors have long known that the engineers underestimate the difficulties and complications involved in pinning down the phenomena of living organisms to definite mathematical lines and curves. The engineer likes to solve his problems logically and directly. He asks the subject if he is comfortable and plots a point and later a curve from the replies elicited. The physiologist believes that the correct procedure is somewhat more complicated. The two viewpoints must be completely coordinated before a true picture appears.

*Director of Research and Education, Refrigeration and Air Conditioning Institute. Member of Board of Consulting and Contributing Editors.

Silica Gel Air Conditioning System Serves Rotogravure Printing Plant

By Herbert E. Ryerson*

ROTOGRAVURE printing is a manufacturing process that well typifies how important air conditioning is to modern industry, for under certain weather conditions it would be practically impossible to operate without control of the temperatures and humidities which markedly affect many of the steps in the production of rotogravure work. When Kable Brothers Co., Mt. Morris, Ill., launched their new rotogravure department earlier this year—the initial investment for which amounted to some $175,000—an air conditioning system of the chemical dehydration type using silica gel was incorporated in the plans.

Printing from a copper cylinder on which the design or picture has been depressed by etching is known technically as *intaglio* printing, and is produced under various trade names, "rotogravure" being one of them. The process is used to reproduce pictorial and printed matter that is to have a large edition—say 100,000 copies or more. The series of illustrations showing the various steps, from the "shooting" of the copy to be reproduced on a film negative to the press from which the signatures or sections of the publication being printed come, gives a "bird's eye" view of what is involved in rotogravure work, and will serve as a helpful preliminary to the description of the air conditioning system.

An air conditioning system was selected that would positively maintain an inside condition of 72 F dry bulb, 57.5 F wet bulb, 40 per cent relative humidity, with 46 grains of moisture per pound of air, the year 'round. As the plant is situated in a section of the country where rapid fluctuations in climatic conditions occur, a system with extreme flexibility had to be selected. The outside design conditions against which the above inside condition must be maintained are, in summer, 100 F dry bulb, 79.5 F wet bulb, 120 grains of moisture per pound; and in winter —10 F. The silica gel method was selected as

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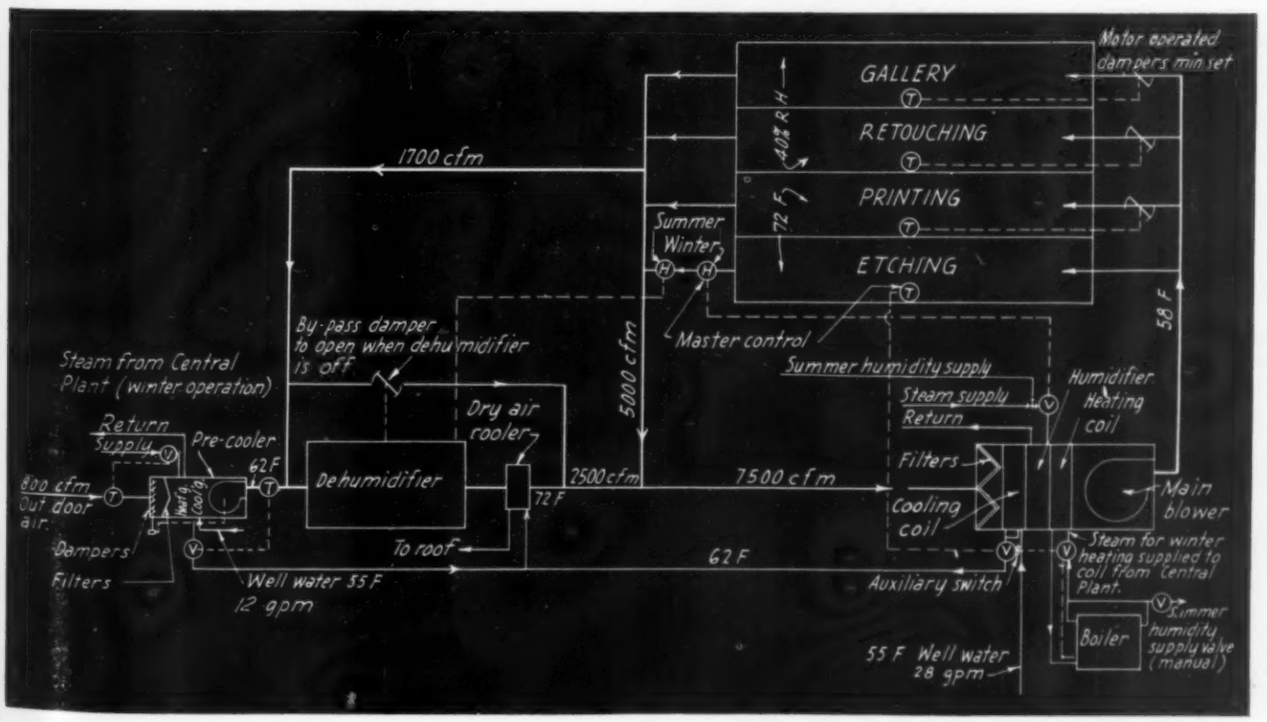
Flow diagram for the air conditioning system at Kable Brothers Co.



it affords independent control of humidity and temperature at all times regardless of change of internal or external loads. The sensible heat is removed by passing the air through a fin type coil through which 55 F well water circulates. The latent heat is controlled by means of the adsorbent, silica gel.

The total installed capacity is equivalent to 18.2 tons of refrigeration, divided as 11.2 tons sensible heat and 7 tons latent heat. Provision was made so that if during the summer the outdoor temperature falls below the temperature to be maintained in the space an auxiliary gas boiler will turn on. The equipment required to handle this load is—

1 Silica gel dehumidifier and dry air cooler.

1 Conditioning cabinet with blowers, ½ hp motor and starter, 8-row cooling coil, 1-row heating coil and filters. This unit to be used for precooling and preheating all outdoor air.

1 Conditioning cabinet containing blowers, 3 hp two speed motor and drive, 1 6-row and 1 4-row cooling coil, 2-row heating coil, humidifier and filters.

Complete control system.

The flow diagram shows the component parts of this system.

Operation of the System

Summer—The main blower and precooler blower are manually operated and run continuously when processing is being done in the rotogravure department. Eight-hundred cfm of outdoor air entering the precooler will be cooled to 62 F dry bulb. Modulating temperature control placed in the precooler blower outlet operating a modulating water valve on the precooler coil maintains this temperature.

Relative humidity is controlled by the humidistat which starts and stops the dehumidifier unit. The dehumidifier treats 800 cfm of precooled air and 1700 cfm of recirculated air. When the humidistat is satisfied the dehumidifier stops and the bypass damper opens to pass 2500 cfm of air.

Temperature is controlled by master proportioning thermostats situated in the etching room. As the heat level increases the thermostat opens the modulating water valve which circulates 55 F water through the main cooling coil. Secondary control in the gallery, printing, retouching and adjacent rooms is accomplished by modulating thermostats operating volume dampers with minimum set in the ducts to these various spaces. As the heat decreases the water valve closes. Should the space continue to cool below 72 F the water valve closes and an auxiliary switch completes the circuit from the heating thermostat to the proportioning steam valve and boiler. If the temperature continues to decline, the steam valve continues to open, and the gas

"Bird's Eye" View of Rotogravure Process

Step 1—Copying camera, first step in the rotogravure process. The photographer "shoots" the copy to be reproduced on a film negative, reducing it at the same time to the proper size

Step 2—Retouching a negative. Working over a ground glass lighted from below, the retoucher, with pencil and brush, restores delicate lights and shadows lost or accentuated too much by the camera

Step 3—Retouching a positive. The photographer takes a retouched negative, makes a positive print on celluloid, and turns it over to the positive retoucher for final inspection and correction before it is ready for layout and printing.

Step 4—Printing the carbon tissue. After the layout man assembles positives and onion-skin proofs of type matter into page form, all on flexible celluloid, he mounts them, sixteen pages together, in the vacuum printing frame, and with strong arc lights, transfers the images to sensitized carbon tissue. The carbon tissue comes in rolls and is cut into sheets of convenient size. Because it is very sensitive to changes in temperature and humidity, the processing departments of rotogravure plants require air conditioning

Step 5—Lay-on machine. Here the carbon print is transferred to the copper cylinder. Pencil register marks made on the paper back of the print before it is removed from the printing frame are the means of locating each page on the cylinder in exact position. One edge of the print is temporarily fastened down with rubber tape, the heavy squeegee roller is let down, and by application of water, the print is made to adhere to the cylinder. The transferred film is then developed by the further application of hot water, after which it is cooled and dried in a room free from dust and variations in temperature and humidity

Step 6—Etching the cylinder. After the surfaces that are not to print are painted out with varnish, etching fluid of graduated strengths is sloshed over the cylinder by hand as it is slowly turned by an assistant. Type and picture sections of the cylinder are etched separately, the portions not being worked on being protected by acid resistant varnish

Step 7—The cylinder on the press, with the web of paper passing between the printing cylinder and a rubber impression roller, fully printed and just on the point of entering the drying chamber. As the cylinder revolves, the lower part passes through a trough of ink. Pressure exerted by the impression roller causes the watery ink to be sucked out of the tiny wells etched in the cylinder. Because of the large amount of ink used, it is necessary to dry the paper before it reaches the folder; this is accomplished first by using a highly volatile solvent—naptha—to thin the ink, and second by passing the web of paper over water cooled rollers to set the ink. The naptha fumes are carried away by means of heated air conveyed by ducts to each of the drying chambers, and mechanically exhausted through ducts from these chambers, as shown in the view of the press

Step 8—The folder. Here packer boys are removing the printed sections of a magazine

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fired boiler continues to steam until the temperature in the space again reaches 72 F and then shuts off. The water cooling cycle will then go into operation as previously outlined. Simultaneously, with the boiler turning on for heating, the individual room thermostats are automatically reversed in operation from cooling to heating thermostats.

The function of the precooler is to positively introduce 800 cfm of outdoor air at all times; when the precooler blower is turned off, the outdoor air damper shuts and the water valve closes.

Winter—The main blower and precooler blower will operate continuously. When the outdoor air temperature reaches 35 F, the thermostat in the outdoor air stream opens the steam valve on the coil, preheating the air.

The auxiliary boiler is valved off manually, the gas turned off manually and steam is admitted to the mains from the central heating system. Control is maintained from the master heating thermostat operating the modulating steam valve.

Humidity is controlled from the master humidistat operating the steam valve to the humidifier. This humidistat is mechanically interlocked with another humidistat operating the dehumidifier.

Another item of control on this system is that the valve on the main cooling coil will close automatically if the main blower is shut down and similarly the water valve on the precooler will close when the precooler blower is stopped. The modulating steam and water valves are interlocked in such manner that the steam cannot be turned on at the same time water is used for cooling. Likewise, the winter humidifier cannot operate when the dehumidifier is functioning. After winter weather has set in the main circulating fan is manually put on slow speed.

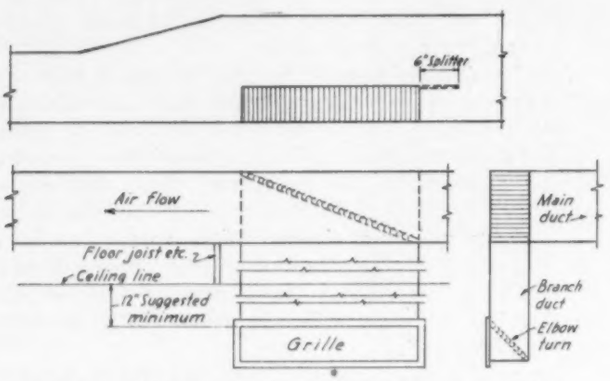
The total air circulated is 7500 cfm in summer and 5000 cfm in winter. Eight hundred cfm of outdoor air

Above
Close-up of some of the equipment, with the duct for the mixture of return and precooled air in the left foreground and the activation exhaust duct at the extreme right. The dry air cooler is in the center

The air conditioning equipment for the rotogravure department, showing the supply ducts for the various zones. In the background are, left to right, the main air circulator, the precooling and preheating unit, and the dehumidifier unit

is positively introduced, both summer and winter, and the dehumidifier is capable of treating 2700 cfm of air. The total maximum hourly requirements, including the power for all air circulation, and dehumidification, but not including water pumping, are: Power, 5.8 kw; gas, 262,000 Btu.

The duct work is unique as square elbows with duct turns are used throughout. Because the branch ducts



Typical detail showing branch take-off from main duct

had to be placed in the room partitions which are directly under the main supply ducts, the method of taking off the branch ducts shown in the detail had to be resorted to.

Outdoor conditions as severe as 98 F and 130 grains of moisture per pound of air have been noted but the system has had no difficulty in maintaining the inside condition of 72 F and 40 per cent relative humidity.

Cough Drops Are Air Conditioned

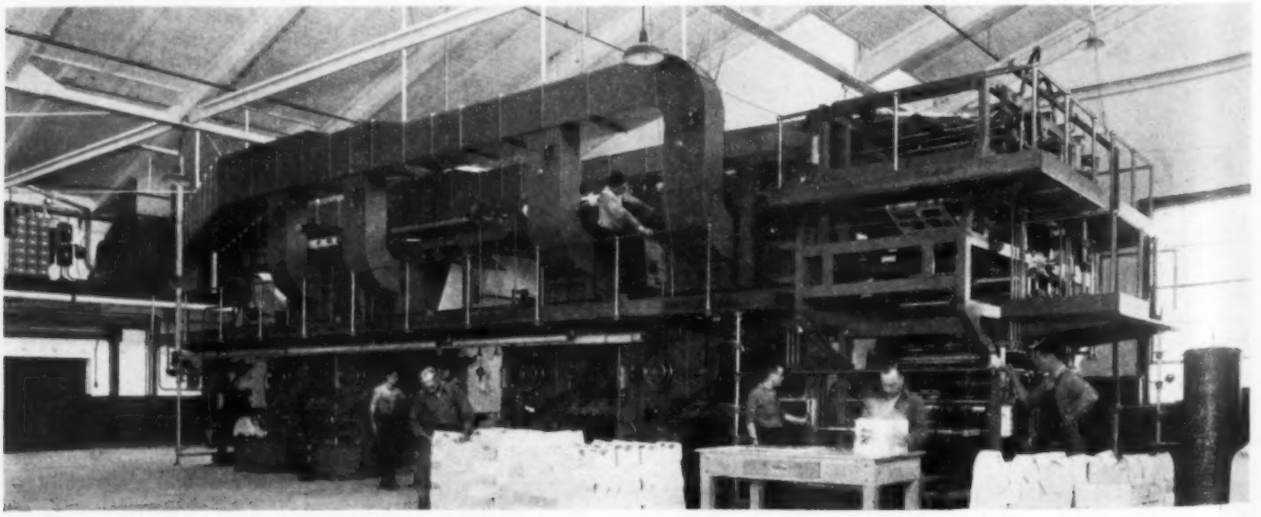
In the making of cough drops, as carried out at the plant of the F & F Laboratories, Inc., Chicago, the basic ingredients are mixed and cooked in large steam jacketed kettles as the initial step. The resulting viscous mass of "cough drops in the raw" is then kneaded and worked over on a large circular table, where the medicinal ingredients are added in carefully measured proportions. From this table, strips of the substance go through a wall separating the two rooms to an ingenious revolving machine which forms the individual drops. They then pass through an enclosed conveyor through which dehumidified air is forced, and then to the hoppers that feed the packaging machinery.

It is after the drops are formed that air conditioning enters the picture, for without the proper temperatures and humidities they stick together. These lozenges are of a hygroscopic nature and to prevent their taking up moisture, it is necessary to keep them in an atmosphere having an absolute humidity of 66 grains of moisture per pound of air or less. Then too, a sugar dust is given off from the product in process which is deposited on the handling equipment. When this dust absorbs moisture a very gummy condition results and if this substance is allowed to accumulate on the equipment eventually it will be necessary to close down while the machinery is cleaned. The air condition which has been found to be most suitable is 80 F dry bulb and 40 per cent relative humidity. This is also a very comfortable condition for the employees to work in.

A 10 ton compressor is required to operate constantly during the manufacture and packing of the lozenges to remove the sensible heat from the product itself, and that given off from lights and motors, sun effect, people, etc. An auxiliary five ton unit controlled by a thermostat "floats" on the line and cuts in and out as the sensible heat from sun effect, increased temperatures, etc. demands.

The normal latent load is equivalent to about four tons of refrigeration, and it is handled separately with a silica gel dehumidifier, which has been designed to handle the load against an outside condition of 120 grains of moisture per pound of air. Occasionally a condition of 140 grains per pound has been observed and to insure that the inside moisture condition does not rise above the absolute condition of 66 grains of moisture per pound of air a smaller dehumidifier unit is installed to act as an auxiliary to remove any increase in moisture. This unit has an equivalent refrigeration capacity of about two tons.

The four-unit rotogravure press at Kable Brothers, representing an investment of almost $100,000, and standing 50 ft long, 13 ft wide, and 15 ft high. The ducts convey and exhaust heated air to the drying chambers through which the web of paper passes after passing between each printing cylinder and impression roller, as described in Step 7. To the left are the supply and exhaust fans for the drying system



Rules for Heating Boiler Selection Continued in This Month's Heating ✦ Piping and Air Conditioning Summary Sheets

[Pages 5-8 were published last month]

represent the minimum recommended for good design, and larger allowances may be used to advantage in many cases, especially with expensive fuel where a high efficiency is desirable. A practice frequently followed with small boilers is to provide for covered piping loss and warming-up allowance by selecting a boiler for which the manufacturer's rated output is twice the equivalent load of standing radiation plus bare piping and water heating.

Steam boilers selected according to Table 5 should be able to bring a direct cast iron radiator system with its piping up to operating temperature within 1 hr. Systems consisting mainly of unit heaters or other concentrated load can be brought to operating temperature in a shorter time.

Much confusion has arisen through lack of agreement between catalog ratings of different boiler manufacturers. Such ratings differ in the allowances included for pipe losses and warming up. In some instances the ratings denote the actual sq ft of steam or water radiation which a boiler can carry, in addition to piping tax, etc., and therefore require no additional percentage for pipe losses and warming up. Other manufacturers rate their products with reference to heat absorption in the boiler expressed in sq ft of radiation, which, of course, requires that pipe losses and warming-up be added to heat emission of the radiation in selecting a boiler. Another system of rating requires that pipe losses be lumped with standing radiation, but provides for warming-up by the way ratings are given. Some manufacturers have changed from one system to another when issuing a new catalog.

A good general rule for sizing steam heating boilers to meet the maximum load during the warming-up period and provide satisfactory efficiency under normal operation is to provide 1 sq ft of boiler heating surface for each 14 sq ft of equivalent 240 Btu radiation represented by standing radiation, piping loss and domestic water heating. This is equivalent to letting 10 sq ft of boiler heating surface represent one boiler horsepower, which is evident from the following equation in which x is the sq ft of 240 Btu radiation per sq ft of boiler heating surface.

One boiler horsepower $= 34.5 \times 970.4 = x \times 10 \times 240$

$x = 13.95$, or approximately 14

where 34.5 is lb of steam per hr evaporated from and at 212 F and 970.4 is the latent heat of evaporation of water at atmospheric pressure in Btu per lb. In this case it is assumed that pick up will be obtained by operating the boiler at a rate exceeding 100 per cent referred to a boiler horsepower basis.

With boilers in small industrial jobs and residences, it is advisable to reduce the 14 sq ft figure to about 10 sq ft of radiation per sq ft of boiler heating surface, especially where full automatic (intermittent) oil firing is used. This tends to keep the stack temperature down with a bettering of efficiency in the case of such oil burning installations where the burner is either going with maximum flame or not at all. According to Harding and Willard,[3] "With house heating boilers either for water or steam, it is probably not desirable in the interests of economy to require a heat absorption exceeding 1800 to 2400 Btu per sq ft per hr, depending upon size of boiler. As each sq ft of radiating surface requires about 240 Btu per hr for steam and 150 Btu for hot water, 1 sq ft of heating surface would, under these conditions, supply from 7½ to 10 sq ft of radiating surface for steam, and 12 to 16 sq ft for hot water. These values are for average operating conditions and may be exceeded under maximum conditions of operation by 100 per cent."

[3]Mechanical Equipment of Buildings, Vol. I, Second Edition, p. 90.

Selecting the Right Size Heating Boiler†

By Sabin Crocker*

Item 3—Computation of Load Due to Domestic Hot Water Requirements

Where the domestic hot water supply is heated from a building heating boiler, the corresponding load must be taken into account in sizing the boiler. Btu required per hr and equivalent nominal radiation corresponding to various gallon-per-hour water heating rates are given in Table 4 for a series of temperature rises. Indirect heaters,[2] fire box coils and storage tanks sometimes are rated on a 3 hr basis instead of a 1 hr, or the rated water temperature rise may be given as ⅓ of that required to give a satisfactory water temperature. Where this is the case, a corresponding adjustment should be made in using Table 4.

The water heating loads given in Table 4 represent average values over the entire period of heating plus an allowance of 15 per cent. The 15 per cent increased capacity provides an allowance to compensate for radiation losses from the storage tank and circulating piping after the water has begun to warm. The values given in Table 4 agree with the figure of 1⅓ sq ft of steam radiation (or 2⅓ sq ft of water radiation) per gal of storage tank capacity sometimes given in catalogs, bearing in mind that the 1⅓ sq ft figure is on a basis of taking 3 hr to heat the tank to a satisfactory temperature. The value of ½ sq ft of steam radiation given in some catalogs is inadequate if the storage tank is to be warmed in 3 hr. There is some justification, however, for the practice of omitting the application of any further piping tax or pick-up allowance for the water heating load beyond the 1⅓ sq ft referred to above.

Indirect water heaters are sold on a basis of their water heating capacity, and catalog data can be used for computing load on the boiler. Similar ratings are available for some types of direct water heaters known as fire pot generators, water backs and the like. In the case of pipe coil heaters placed in the fire box, a heat transfer rate of 12,000 to 15,000 Btu per sq ft per hr can be assumed, depending on how the coil is placed with respect to the fire and the extent to which it has scaled. This is equivalent to a 240 Btu radiation load of 50 to 62.5 sq ft per sq ft of coil surface. The same values can be applied in the case of cast iron or brass water backs where catalog information is not available. Assuming a 100 F water temperature rise, each sq ft of water back or fire box coil surface is capable of heating 12½ to 15½ gal of water per hr, including a 15 per cent allowance for radiation losses from storage tank and circulating piping.

In some installations, steam coils immersed in tanks are used for water heating purposes. Water heating capacities and corresponding boiler loads for such coils of brass or iron pipe can be read from Fig. 2. These values are for horizontal pipe coils and contain an allowance of

*Engineer, The Detroit Edison Co. Member of Board of Consulting and Contributing Editors.

†Summarized and revised from a series of three articles published in Heating, Piping and Air Conditioning, February-March-April, 1932.

[2]"Indirect heaters" as used here refers to copper coils or other surface placed below the boiler water line, either integral with or external to the boiler proper.

Here is the third installment of a new series of "summary sheets," on this and the preceding page. The purpose of these sheets is to make available for quick reference for everyday use information needed in heating, piping and air conditioning work. . . . For complete information, refer to the original article from which these data were obtained, as the purpose of these summaries is not to take the place of the article, but rather to put the essentials into convenient reference form. . . . The Editors will appreciate your suggesting what type of material you'd like presented in this way. . . . Address HEATING, PIPING AND AIR CONDITIONING, 6 North Michigan Avenue, Chicago, Ill.

Table 4—Water Heating Loads vs. Temperature Rise for Various Gallon per-Hour Rates[a]

Gal Heated Per Hr	100 F Rise		110 F Rise		120 F Rise		130 F Rise		140 F Rise		150 F Rise	
	1,000 Btu Per Hr	Equivalent Sq Ft 240 Btu Radiation	1,000 Btu Per Hr	Equivalent Sq Ft 240 Btu Radiation	1,000 Btu Per Hr	Equivalent Sq Ft 240 Btu Radiation	1,000 Btu Per Hr	Equivalent Sq Ft 240 Btu Radiation	1,000 Btu Per Hr	Equivalent Sq Ft 240 Btu Radiation	1,000 Btu Per Hr	Equivalent Sq Ft 240 Btu Radiation
5	4.80	20	5.28	22	5.76	24	6.24	26	6.72	28	7.20	30
10	9.60	40	10.56	44	11.52	48	12.48	52	13.44	56	14.40	60
20	19.20	80	21.12	88	23.04	96	24.96	104	26.88	112	28.80	120
30	28.80	120	31.68	132	34.56	144	37.44	156	40.32	168	43.20	180
40	38.40	160	42.24	176	46.08	192	49.92	208	53.76	224	57.60	240
50	48.00	200	52.80	220	57.60	240	62.40	260	67.20	280	72.00	300
60	57.60	240	63.36	264	69.12	288	74.88	312	80.64	336	86.40	360
70	67.20	280	73.92	308	80.64	336	87.36	364	94.08	392	100.8	420
80	76.80	320	84.48	352	92.16	384	99.84	416	107.5	448	115.2	480
90	86.40	360	95.04	396	103.7	432	112.3	468	121.0	504	129.6	540
100	96.00	400	105.6	440	115.2	480	124.8	520	134.4	560	144.0	600
120	115.2	480	126.7	528	138.2	576	149.8	624	161.3	672	172.8	720
140	134.4	560	147.8	616	161.3	672	174.7	728	188.2	784	201.6	840
160	153.6	640	169.0	704	184.3	768	199.7	832	215.0	896	230.4	960
180	172.8	720	190.1	792	207.4	864	224.6	936	241.9	1008	259.2	1080
200	192.0	800	211.2	880	230.4	960	249.6	1040	268.8	1120	288.0	1200
250	240.0	1000	264.0	1100	288.0	1200	312.0	1300	336.0	1400	360.0	1500
300	288.0	1200	316.8	1320	345.6	1440	374.4	1560	403.2	1680	432.0	1800
400	384.0	1600	422.4	1760	460.8	1920	499.2	2080	537.6	2240	576.0	2400
500	480.0	2000	528.0	2200	576.0	2400	624.0	2600	672.0	2800	720.0	3000

Footnotes, Table 4

[a]Table is computed for water having a density of 8⅓ lb per gal and a specific heat of one Btu per F. Loads are based on a boiler tax equal to 4 sq ft of 240 Btu steam radiation for each gallon of water heated per hour through 100 F, computed as follows:

Heat required to raise water temperature.. = 8⅓ × 100 = 833 Btu/hr = 3.47 sq ft steam radiation per gal.

Heat lost by radiation from storage tank and circulating piping ... = 127 Btu/hr = 0.53

Total ..... 960 Btu/hr 4.00

The allowance for radiation loss from storage tank and circulating piping represents approximately 15 per cent of the heat required to raise the water temperature.

50 per cent for fouling of the pipes. Consequently the maximum load with clean, new pipe may be twice that shown, which should be taken into account in sizing the boiler. All pipe surfaces considered here and elsewhere in this article are external.

Item 4—Satisfactory Warming-Up Period

The boiler must have considerable excess capacity in order to attain normal operating condition; various empirical rules have been proposed for determining what boiler capacity should be provided for warming up different heating systems. According to the *A. S. H. V. E. Guide* 1937 the excess capacity based on the summation of items 1, 2 and 3 should not be less than as indicated in Table 5.

The total Btu loads obtained by adding the percentages of Table 5 represent the rate of heat absorption required of the boiler water. For satisfactory operation the boiler and fuel burning cuipment must be large enough to carry this load without undue forcing of the fire and with a satisfactory stack temperature.

Ability to carry the load hinges principally on grate area, or burner capacity with liquid or gaseous fuel, and on boiler heating surface. Adequate furnace volume for proper combustion is a necessary requisite which may be assumed as provided for in good boiler design. Reasonable fuel burning and heat transfer rates are discussed in subsequent paragraphs with relation to boiler efficiency. The percentage allowances given in Table 5

Table 5—Warming Up Allowance[a]

Load representing summation of Items 1, 2 and 3

Load in Btu per Hr	Equivalent Sq Ft 150 Btu Radiation (Water)	Equivalent Sq Ft 240 Btu Radiation (Steam)	Percentage Capacity to Add for Warming Up
Up to 100,000	Up to 670	Up to 420	65
100,000 to 200,000	670 to 1,340	420 to 840	60
200,000 to 600,000	1,340 to 4,000	840 to 2,500	55
600,000 to 1,200,000	4,000 to 8,000	2,500 to 5,000	50
1,200,000 to 1,800,000	8,000 to 12,000	5,000 to 7,500	45
Above 1,800,000	Above 12,000	Above 7,500	40

[a]This table refers to hand fired solid fuel boilers. A factor of 25 per cent over design load is adequate when oil or gas is the fuel.

Heating · Piping
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Radiation and Convection Across Air Spaces in Frame Construction

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THE fact that the air space between the studs in ordinary frame construction had definite insulating value has been long known, but its actual value was not appreciated until comparatively recent years.

In 1929 Prof. F. B. Rowley[1] was one of the first to attempt to evaluate the actual insulating effect of ordinary air spaces, and subsequently considerable interest was aroused in air space insulation when the U. S. Bureau of Standards, in Circular No. 376, stated that from 50 to 80 per cent of the heat transfer across ordinary air spaces was due to radiation. A number of other experimenters, including Schad, Queer, Van Dusen, Gregg, Mason, Griffiths and Davis, determined the insulating value of air spaces, but none of these, with the exception of Griffiths and Davis, attempted to evaluate separately radiation and convection. It was also just about this time that metal foil for insulation became commercially available so that one could minimize the radiant transfer of heat across an air space. The principles involved in air space insulation are radically different from those for ordinary insulators and there has been much confusion among engineers as well as laymen due to a lack of knowledge of the fundamental laws of radiation and convection as well as a lack of experimental data.

At the present time there are practically no data available in regard to the rate of heat transfer across air spaces that are not in the vertical position, although it is well known that the rate of heat transfer across horizontal air space must be much greater when the heat is passing upward rather than downward. This difference is much more marked in the case of reflective type insulation, because radiation is minimized and convection remains the chief factor involved in the heat transfer.

The purpose of this paper is two-fold: first, to state again the fundamental laws of radiation and convection because of the apparent lack of understanding; and second, to give new experimental data in regard to the rate of heat transfer across full-sized air spaces in various positions bounded by surfaces that are both good and poor reflectors of heat radiation.

Radiation

The fundamental laws of radiation are well established, both theoretically and experimentally. The transfer of heat by means of radiation across an air space is dependent upon the temperature of the two boundary surfaces and their respective emissivities. Thickness of the air space has no appreciable effect upon the amount of radiation transfer. For example, if two infinite parallel plates are considered at temperatures of 60 F and 20 F, respectively, the rate of heat transfer by radiation would be essentially the same if the distance between these plates were one inch, one foot, or one mile.

The emissivity of a plane surface is merely a factor indicating the relative amount of radiation from the surface in question as compared to a perfect radiator (*black body*) under the same conditions. If the emissivity of a *black body* is termed unity, then the emissivity of all real surfaces will be less than one. The emissivity of a number of common surfaces found in buildings at a temperature around 70 F is given in Table 1.

From the values given in Table 1 it will be noted that most of the non-metals have high emissivities in the neighborhood of 0.9, while the metals when not oxidized have very low emissivities around 0.05. Aluminum and bronze paint that are a combination of metals and a non-metallic vehicle have an emissivity about half-way between the two values stated.

Heat radiation striking an opaque surface must either be absorbed or reflected. Consequently, the radiation absorbed by a surface plus that reflected must equal in amount the radiation striking the surface. It is also obvious that if a material is a good absorber of radiation, it must be also an equally good emitter of radiation. For example, if a body is placed in an evacuated space and allowed to come to temperature equilibrium, the radiation absorbed must equal that emitted.

Consequently, if $a =$ the absorptivity, $e =$ the emissivity, and $r =$ the reflectivity of a surface, then

$$a = e = 1\text{-}r \qquad (1)$$

As far as the rate of heat transfer across an air space by radiation is concerned, it makes no difference whether

Table 1—Total Emissivity of Plane Surfaces at 70 F

Surface	Total Emissivity
Wood	0.9
Plaster	0.93
Paper	0.9
Black paint	0.9
White paint	0.9
Aluminum paint	0.4 –0.65
Coated papers	0.32–0.64
Aluminum foil	0.05
Aluminum oxidized	0.11
Copper polished	0.04
Copper oxidized black	0.78
Iron polished	0.06
Iron, rough oxide layer	0.81
Glass	0.9
Chrome plate, polished	0.04

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[1] Thermal Resistance of Air Spaces, by F. B. Rowley and A. B. Algren, A. S. H. V. E. Transactions, Vol. 35, 1929.

Insulating Value of Bright Metallic Surfaces, by F. B. Rowley, A. S. H. V. E. Transactions, Vol. 40, 1934.

Presented at the Semi-Annual Meeting of the American Society of Heating and Ventilating Engineers, Swampscott, Mass., June, 1937.

the reflective surface is on the cooler or warmer side of the space.

Emissivity varies with the temperature of the surface, while absorptivity may vary with the temperature of the source of radiation as well as the temperature of the receiving surface. Black and white paint have essentially the same emissivity at room temperature, but if exposed to solar radiation one will find that the black paint will absorb many times as much heat as the white paint. Aluminum foil will emit at room temperature only about 5 per cent as much radiation as a white painted surface but, when exposed to radiation from the sun, the aluminum will not reflect as well as the white paint.

Every surface, regardless of its temperature, is radiating and receiving heat by radiation. In the case of the transfer of heat by radiation across an air space, one is concerned only with the net heat transfer between the two surfaces at different temperatures. This can be calculated by the well-established Stefan-Boltzmann Law.

$$q_r = A\, e_{ett}\, \sigma\, (T_1^4 - T_2^4) \qquad (2)$$

where

q_r = net rate heat radiation, Btu, hour.
A = area, sq ft.
e_{ett} = effective emissivity.
σ = Stefans constant = 17.2×10^{-10} Btu, hour^{-1}, feet^{-2}, $F_{abs.}^{-4}$
T_1 = absolute temperature deg F $(460 + t_1)$ of warmer surface.
T_2 = absolute temperature deg F $(460 + t_2)$ of cooler surface.

In dealing with the net radiation between two parallel surfaces, the emissivity of each surface must be considered. It can be demonstrated that the *effective* emissivity or e_{ett} used in equation 2 is a combination of the two individual emissivities. This effective emissivity can be calculated as follows:

$$e_{ett} = \frac{1}{\frac{1}{e_1} + \frac{1}{e_2} - 1} \qquad (3)$$

where

e_1 = emissivity of warmer surface.
e_2 = emissivity of cooler surface.

For example, if $e_1 = 0.90$ and $e_2 = 0.90$; then $e_{ett} = 0.82$.
and, if $e_1 = 0.05$ and $e_2 = 0.90$; then $e_{ett} = 0.05$.

Formula 3 is based on infinite parallel plates, but there will be little error involved if it is applied to the ordinary air spaces found in frame construction.

To make easier the calculation of the transfer of heat by radiation, Fig. 1 gives values of σT^4 for the usual temperatures of the surfaces facing such air spaces.

Example: Find the heat transfer by radiation across an air space between studs, where one surface is paper (plasterboard) at a temperature of 60 F and the other wood sheathing at a temperature of 20 F.

From chart $\sigma\, T_1^4 = 126.0$ Btu per hour per square foot.
$\sigma\, T_2^4 = 91.2$ Btu per hour per square foot.

Difference $\sigma\, (T_1^4 - T_2^4) = 34.8$ Btu per hour per square foot.

$$\text{The effective emissivity} = \frac{1}{\frac{1}{0.9} + \frac{1}{0.9} - 1} = 0.83.$$

For each square foot of surface, the amount of heat transferred by radiation will be

$$q_r = e_{ett}\, \sigma\, (T_1^4 - T_2^4) = 0.83 \times 34.8 = 28.9 \text{ Btu per hour per square foot}$$

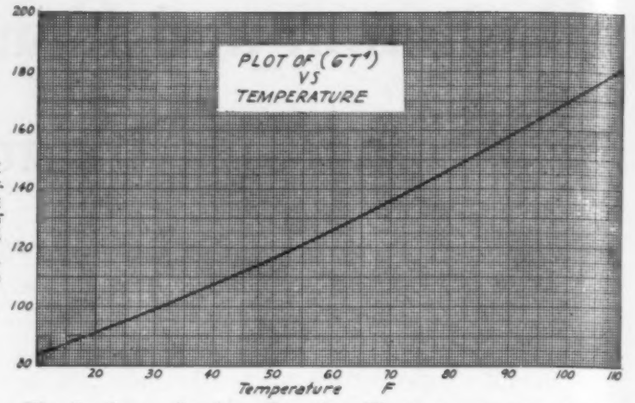

Fig. 1—Curve showing plot of $\sigma\, T^4$ vs. temperature, degrees Fahrenheit

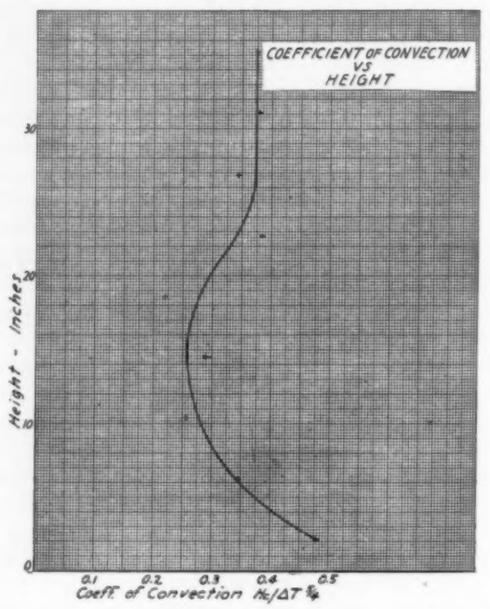

Fig. 2—Curves indicating variation in coefficient of convection vs. height

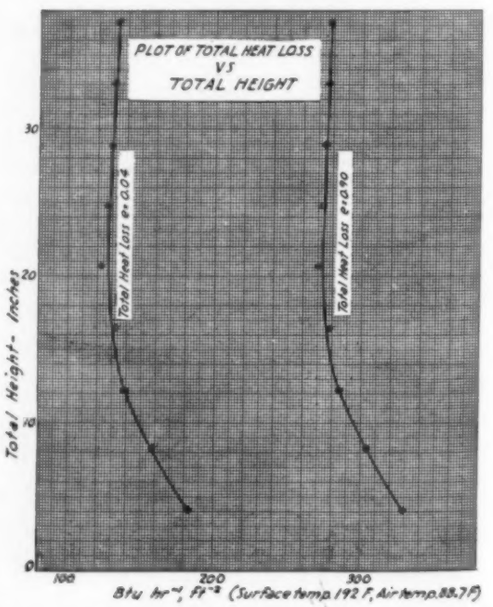

Fig. 3—Curves indicating total heat loss vs. total height

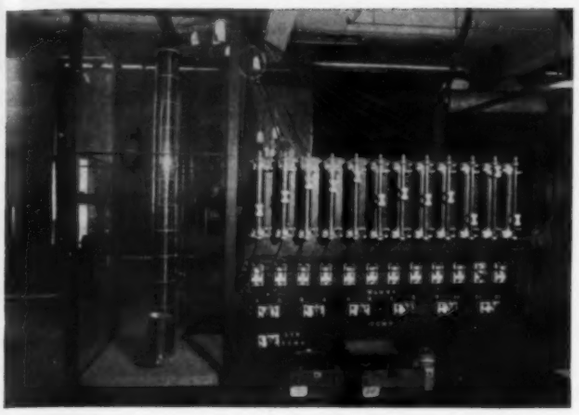

Fig. 4—View of apparatus used to determine variation of convection with height

Fig. 5—View of air space apparatus

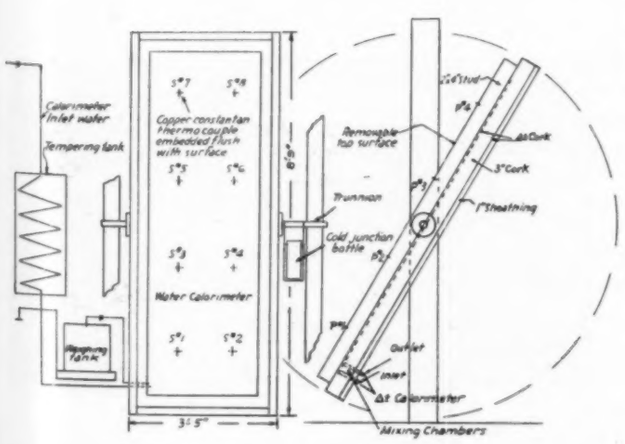

Fig. 6—Diagrammatic arrangement of air space apparatus

Convection

Convection as a means of transfer of heat across an air space follows very different laws and is much more complicated than radiation or conduction.

It has been demonstrated experimentally by a number of experimenters that heat transfer by natural or free convection varies approximately with the 5/4 power of the temperature difference between the surfaces on each side of an air space. For temperature drops as usually found in building walls, the transfer of heat by both conduction and radiation is approximately proportional to the temperature difference. If the temperature difference across an air space were increased from 5 F to 40 F, the radiation would be increased about eight times, while the convection would be increased more than twelve times.

In the case of radiation, the position of the air space (vertical, horizontal, etc.) has no effect, but it has a very marked effect on convection. The rate of heat transfer by convection across a horizontal air space with the heat flowing upward is roughly three times what it would be with the heat flowing downward.

Convection also varies with the height of the air space up to approximately 2 ft. Figs. 2 and 3 indicate this variation as found in an apparatus set up in the laboratory, as shown in the photograph of Fig. 4, and which gives essentially the same data as found by Griffiths and Davis. It will be seen readily that experiments upon natural convection must be made upon nearly full size air spaces, and that tests made upon samples 1 ft high will give higher values if applied to an 8 ft air space.

Since there is apparently little information available in regard to the transfer of heat across air spaces other than in the vertical position and since most of the work on vertical air spaces has been done on relatively small specimens, with little attempt made to separate radiation from convection, it seemed important to carry out an investigation on full sized air spaces. Furthermore, Table 2, given in chapter 5 of THE GUIDE 1937 for conductances of air spaces assumes that both radiation and convection vary proportionately with the temperature difference and also with the mean temperature. This assumption is approximately true for radiation, but is far from true for convection. With ordinary surfaces facing a vertical air space, such as plaster, wood, paper, etc., radiation is responsible for roughly 65 per cent of the total heat transfer and the error is not very serious. In the case of the newer type of reflective insulation, the transfer of heat by radiation is minimized, thus making convection responsible for most of the heat transfer. In this latter case the assumptions made above will lead to very serious errors in the calculation of the insulating value.

It was decided to construct an air space 8 ft high by 2 ft-8 in. wide and 3⅝ in. across, as shown in the photograph of Fig. 5 and diagrammatically in Fig. 6. This

Table 2—Total Heat Loss Percentage Errors for Various Heights

Height of Test Specimen, In.	Total Heat Loss Btu Per Hour Per Sq Ft	Per Cent Error
6	170	31.0 high
9	154	18.5 high
12	140	8.0 high
>16	130	Correct

would correspond to about the normal height of a frame wall air space.

One side of this air space consisted of a steel plate with 180 ft of ¼ in. copper tubing attached as shown in Fig. 7 to make a large water calorimeter. This was backed with 3 in. of corkboard so as to reduce the gain or loss of heat from the room. A frame was built of 2 x 4 in. studs around this plate and on these were fastened either black building paper or aluminum foil on paper, thus enclosing the air space and providing means of minimizing the radiation when desired.

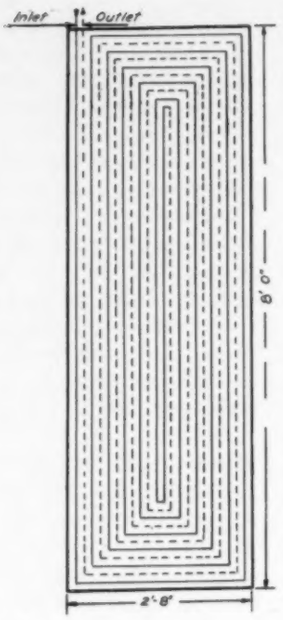

Fig. 7—Diagram showing copper tubing arrangement in water calorimeter

Eight thermocouples were cemented in grooves cut in the steel plate so that its average temperature could be accurately measured. Thermocouples were also attached to the paper or foil on the other side of the air space. In this way the temperature drop across the air space could be determined with precision.

The inlet and outlet temperature of the water in the calorimeter was measured by means of multiple thermocouples in a suitable mixing chamber close to the calorimeter. Before entering the calorimeter, the water passed through a copper coil immersed in water to maintain a constant temperature. This temperature could be varied at will by either heating or cooling the water in the tempering tank. The arrangement of the copper coil is given in Fig. 7, and it produced very uniform temperatures over the whole area of the calorimeter plate.

The whole apparatus was mounted on trunnions so that it could be tipped at any angle desired and with the heat either flowing upward or downward when it was in any position other than vertical.

A semi-precision potentiometer was used to measure the electromotive force developed by the thermocouples. It was possible to read to 0.001 millivolt, which corresponded to about 0.045 F on the single thermocouples and about 0.009 F on the multiple couples for the calorimeter.

Thermocouples were placed on each surface of the cork insulation so that a suitable correction could be made for any gain or loss of heat. The edge loss of heat through the 2 x 4 in. frame was small and is included in the loss through the cork back.

All cold junctions of the thermocouples were kept in thermos bottles filled with cracked ice and water. A careful calibration was made before starting the work.

Tests were conducted in five different positions, horizontal, and 45 deg with heat flowing downward, horizontal, and 45 deg with heat flowing upward, and in the vertical position. Tests were made with aluminum foil facing one side of the air space or with black building paper. In order to determine the coefficients of convection for the different positions, aluminum foil was used for the outer surface so as to minimize radiation. The temperature difference was varied and in one case the direction of heat flow was reversed by sending heated water through the calorimeter rather than cool water. The rate of heat transfer was not affected by having the foil surface absorbing rather than emitting heat.

Results

The accompanying curves express the results of these experiments much better than a table of data.

The relation between temperature difference, degrees Fahrenheit, and the temperature difference raised to the 5/4 power, for use in computing convection, is shown in Fig. 8. It is interesting to observe that if one has 40 F temperature difference rather than 10 F, the heat transfer by convection will be increased 5.6 times rather than just 4 times, as would be the case if convection varied with the temperature difference directly. Radiation, on the other hand, for this same range of temperature would increase nearly proportional to the temperature difference, or about 4 times. For example, if one had a conductance value (radiation plus convection) for a foil lined air space that was experimentally determined, with a temperature difference of 10 F, and it were applied to a case with a 40 F temperature difference, by merely multiplying the conductance value by the temperature difference, the new value would be roughly 25 per cent too low. This is the method in common use today.

Experimental values for the variation of the coefficient of convection with height are indicated in Fig. 2. The coefficient is greatest at small heights, gradually diminishing to a minimum value at roughly 15 in. and then becoming uniform, regardless of height, above 24 in. This effect is probably due to streamline motion of the air over the surface up to a height of about 15 in. and then the air becoming turbulent causes the coefficient to remain constant for all heights greater than about 2 ft. The smoke from a lighted cigarette placed close to the bottom of the column demonstrated clearly the change from streamline to turbulent motion of the air stream.

The variation of the total heat loss versus the total height is indicated in Fig. 3. It shows clearly the error that one can make if data are taken from a relatively small area of low height and then applied to greater heights. With a chrome plated sample ($e = 0.04$) and

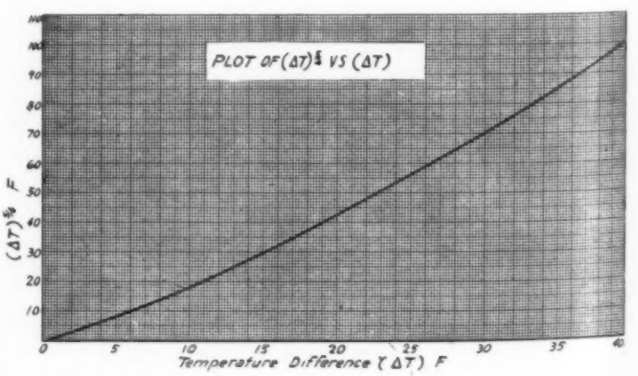

Fig. 8—Curve showing plot of $\Delta T^{5/4}$ vs. temperature difference, degrees Fahrenheit

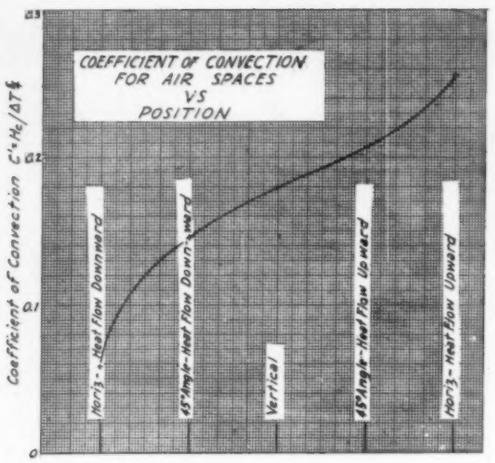
COEFFICIENT OF CONVECTION FOR AIR SPACES VS POSITION
Coefficient of Convection C'=H/ΔT
Horiz. - Heat Flow Downward
45° Angle - Heat Flow Downward
Vertical
45° Angle - Heat Flow Upward
Horiz. - Heat Flow Upward

Fig. 9—Curve indicating coefficient of convection for air spaces vs. position

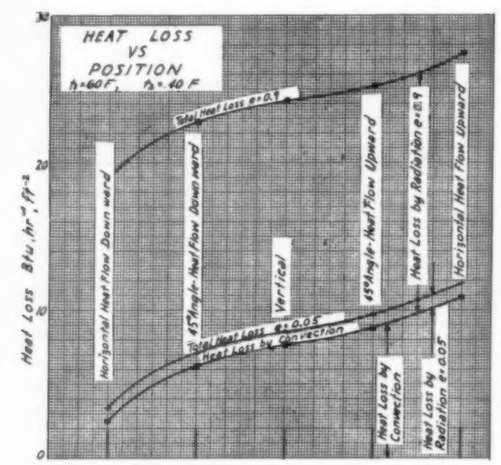
HEAT LOSS VS POSITION
Heat Loss Btu./hr.ft.²
Horizontal Heat Flow Downward
45° Angle - Heat Flow Downward
Vertical
45° Angle - Heat Flow Upward
Horizontal Heat Flow Upward
Heat Loss by Convection
Heat Loss by Radiation

Fig. 10—Curves showing relation of heat loss vs. position

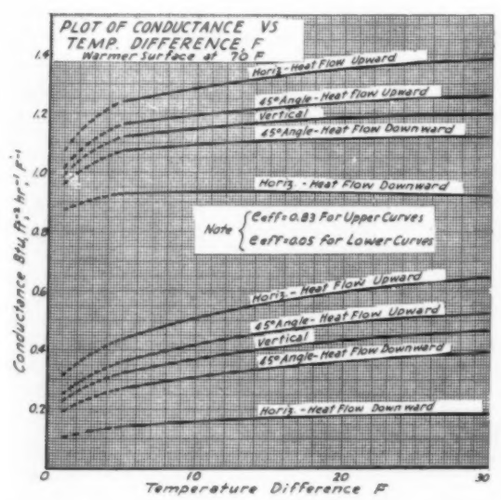
PLOT OF CONDUCTANCE VS TEMP. DIFFERENCE F
Warmer Surface at 70 F
Horiz. - Heat Flow Upward
45° Angle - Heat Flow Upward
Vertical
45° Angle - Heat Flow Downward
Horiz. - Heat Flow Downward
Note
Horiz. - Heat Flow Upward
45° Angle - Heat Flow Upward
Vertical
45° Angle - Heat Flow Downward
Horiz. - Heat Flow Downward
Conductance Btu./ft.²/hr.⁻¹/F⁻¹
Temperature Difference F

Fig. 11—Curves of conductance vs. temperature difference, degrees Fahrenheit

temperature conditions corresponding to those indicated in Fig. 3, the values given in Table 2 will show the error to be expected when experimental data are taken for different heights and then applied to heights greater than 16 in.

In Fig. 9 the effect of position on the coefficient of convection for air spaces is shown. The usual coefficient of convection is designated by C and deals with the transfer of heat from a surface to the surrounding air. The coefficient used in this chart deals with the transfer of heat by convection from one surface to another parallel surface and will be designated by C'. In other words, the temperature difference between two parallel surfaces is used in calculating C' rather than the temperature difference between a surface and the surrounding air that would be used in the case of C.

The large effect that position plays in convection is shown clearly. In the horizontal position, if heat is flowing upward, the coefficient is 0.256 as compared with a value of 0.058 with the heat flow downward, or roughly five times as great. The value for the vertical position is not half-way between these two values but is nearer the higher value, namely, 0.180.

The relation between heat loss and position is illustrated in Fig. 10 for an air space with and without a reflective surface. It also shows the relative amount of heat transferred by convection and radiation for both cases. The results indicated on this chart apply only when there is a 20 F difference in temperature between the surfaces and also when one surface is approximately 60 F and the other 40 F.

The values in Table 3, taken from Fig. 10, show the important part that radiation plays in the transfer of heat when the air space is bounded by ordinary surfaces ($e_{eff} = 0.9$) as compared to the minor part when one of the surfaces is of the reflective type ($e_{eff} = 0.05$).

The variation of conductance with temperature differences that might be found in a building wall air space is shown in Fig. 11. The calculation of radiation is based on the warmer surface being at 70 F. The variation due to mean temperature is not great if it is not more than one would find in building walls, especially in the case where one surface is of the reflective type. In this latter case the error, using data from the chart, would only be from 1 to 3.5 per cent too low if the warmer surface were 90 F and from 1 to 3.5 per cent too high if the warmer surface were 50 F instead of 70 F. This is, of course, due to the small part that radiation plays in the heat transfer when a reflective surface is used. In the case of ordinary surfaces with effective e equal to 0.83, the error would be somewhat greater. With the warmer surface at 90 F, the values from the chart would be from 6.7 to 10 per cent too low and with the warmer surface at 50 F instead of

Table 3—Comparison of Radiation Effects Bounded by Various Surfaces

Position	Total Heat Loss		Per Cent Radiation	
	$e_{eff}=0.9$	$e_{eff}=0.05$	$e_{eff}=0.9$	$e_{eff}=0.05$
Horizontal, heat flow downward	19.0	3.4	87	26
45 deg heat flow downward	22.7	7.1	73	13
Vertical	24.2	8.6	68	10
45 deg heat flow upward	25.3	9.7	65	9
Horizontal, heat flow upward	27.4	11.8	60	8

Table 4—Equivalent Thickness of Insulating Material

Position	Ordinary Surfaces e_{eff} 0.83	One Reflecting Surface e_{eff} 0.05
Horizontal, heat flow downward.	0.32 in.	1.67 in.
45 deg heat flow downward.....	0.27 in.	0.83 in.
Vertical.....	0.25 in.	0.70 in.
45 deg heat flow upward.....	0.24 in.	0.61 in.
Horizontal, heat flow upward...	0.22 in.	0.50 in.

70 F the values would be from 5.9 to 8.7 per cent too high.

If one knows the temperature drop across an air space, with or without one reflective surface, Fig. 11 can be used to determine the total heat transfer across the air space in various positions, provided the temperature ranges are not too far from those used in calculating the chart.

Frequently the insulating value of an air space is compared to that of a good average insulating material. If a temperature difference of 20 F is assumed for a good average insulating material having a coefficient of thermal conductivity equal to 0.30 Btu per hour per square foot per inch per degree Fahrenheit, Table 4 will give the equivalent thickness of such a material corresponding to various types of air spaces.

The values in Table 4 illustrate the large difference in insulating value of an air space with one reflective surface due to its position. It is more than three times as good an insulator in a horizontal position with the heat flowing downward as when in the same position with the heat flowing upward.

The method of calculating the radiation and convection of heat across an air space has been shown, provided the temperatures of the bounding surfaces are known. This is fundamental if one is to design air space insulation intelligently. The architect or builder, however, would have difficulty in calculating the heat loss through a wall containing an air space with just the foregoing information, as the temperatures of the surfaces facing the air space are not known accurately.

It is possible that a complicated nomographic chart could be constructed so that these temperatures could be determined for various indoor and outdoor temperatures, various wall constructions, various effective emissivities and for different coefficients of convection. In order to simplify the problem by specifying certain common conditions, assume an indoor temperature of 70 F and outdoor temperature of 35 F and a typical frame wall consisting of clapboards, building paper, sheathing, studs and plaster. With these assumptions a chart can be constructed which will readily give the necessary surface temperatures for any given effective emissivity and for any given coefficient of convection.

Assume

q = heat flow, Btu per hour per square foot.
C_1 = conductance of plaster plus surface to inside air.
C_2 = conductance of sheathing and clapboards plus surface to outside air.
t_h = temperature of inside air.
t_c = temperature of outside air.
t_1 and T_1 = temperature of warmer surface facing the air space in degrees Fahrenheit and degrees Fahrenheit absolute.
t_2 and T_2 = temperature of cooler surface facing the air space in degrees Fahrenheit and degrees Fahrenheit absolute.
C' = convection coefficient between surfaces.
e_{eff} = effective emissivity of surfaces.
σ = Stefan's constant 17.2×10^{-10} Btu, hour^{-1}, foot^{-2}, F$^{-4}_{abs.}$

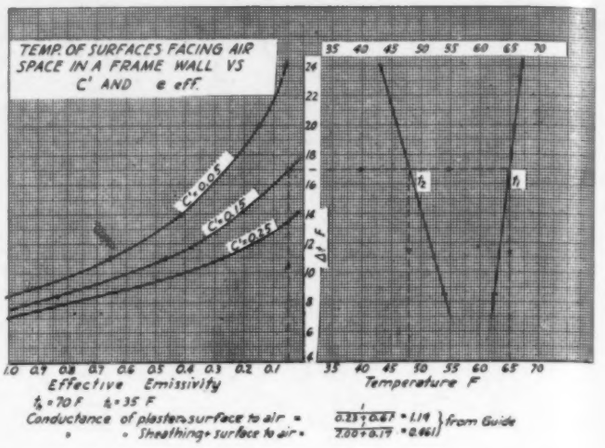

Fig. 12—Chart showing temperature of surfaces facing air space in a frame wall vs. C' and e_{eff}

Then

$$q = C_1(t_h - t_1) = C_2(t_2 - t_c) = C'(t_1 - t_2)^{5/4} + e_{eff}\,\sigma\,(T_1^4 - T_2^4) \qquad (4)$$

For the conditions assumed, THE A.S.H.V.E. GUIDE, 1937, gives values of $C_1 = 1.19$ and $C_2 = 0.461$ and t_1 and t_2 can be calculated for any given e_{eff} and C'.

It is somewhat easier to assume a value of t_1 such as 67 F, then

$$t_2 = \frac{C_1\,(t_h - t_1)}{C_2} + t_c = 43 \text{ F.}$$

Knowing t_1 and t_2 and assuming a value of $C' = 0.05$, one can solve the equation

$$C_1\,(t_h - t_1) = C'\,(t_1 - t_2)^{5/4} + e_{eff}\,\sigma\,(T_1^4 - T_2^4)$$

for a corresponding value of e_{eff}, which in this case equals 0.057. This calculation will give one point on the curve in Fig. 12 for $C' = 0.05$. By repeating this process with different values of t_1, the entire curve for $C' = 0.05$ can be drawn. A similar procedure will produce curves for other values of C'.

Thus, using the left hand side of Fig. 12, the temperature drop across the air space for any given effective emissivity and for any convection coefficient may be determined. By use of the right hand side of the chart, this temperature drop can be converted into the actual temperatures of the two surfaces facing the air space. Once these two temperatures are known, the heat flow can be calculated.

Similar charts may be constructed for any type of wall and for any temperature conditions as to the inside and outdoor air. The values obtained from the chart in Fig. 12 may be used with only a small error for brick veneer walls, and therefore they can be used for most of the common types of residence construction.

Air Conditioning Sales

Installed equipment sold by members of the *Air Conditioning Manufacturers Association* during the first four months of 1937 represented an increase of 180 per cent over total sales in 1936. Sales for the first four months of 1937 reached a total of $41,000,000.

An Alternate Method of Comparing the Dust Arrestance of Air Cleaning Devices

By Arthur Nutting* (*NON-MEMBER*), Louisville, Ky.

INTENSIVE use of the A.S.H.V.E. Standard Code for Testing and Rating Air Cleaning Devices Used in General Ventilation Work over a period of five years has indicated it to be probably as practical in the general testing of all types of filters as any single code can be. For the testing of particular types of filters, certain exceptions to the Code could be made which probably would render it more applicable for the filter in mind, but in general the Code as it exists gives a laboratory comparison of air filters very close to their actual field performance. In brief, the present Code prescribes the following procedures and definitions:

1. Dust standardization.
2. Dust feeding method.
3. Rate of dust feed.
4. Air velocity through filter.
5. Method of rating resistance.
6. Method of sampling for arrestance rating.
7. Method of rating filter for dust-holding capacity.

The method of sampling the dust for obtaining the arrestance rating requires more skill and technique in manipulation than all the other procedures laid down by the Code and at the same time is subject to more possibility of error than any other element of the Code. This sampling is accomplished by drawing through a ¼ in. diameter sampling tube a sample of air on the clean side of the filter. This sample of air is then passed through a porcelain crucible in which all the measurable dust in the air is extracted. The increase in weight of the porcelain crucible is a measure of the filter arrestance. The difficulties of this method are the need for extreme delicacy in weighing, since the increase in weight of the 10 gram crucible is usually in the order of one milligram. Secondly, the sampling tube samples only 1/6 of 1 per cent of the air passing through the filter and any error in taking the sample will be greatly multiplied. Third, errors in weighing are liable to occur because of the somewhat hygroscopic nature of the porcelain crucible and there is the further disadvantage that as the crucible becomes loaded with dust the sampling rate would be reduced, thereby requiring constant attention for keeping the sampling rate in balance.

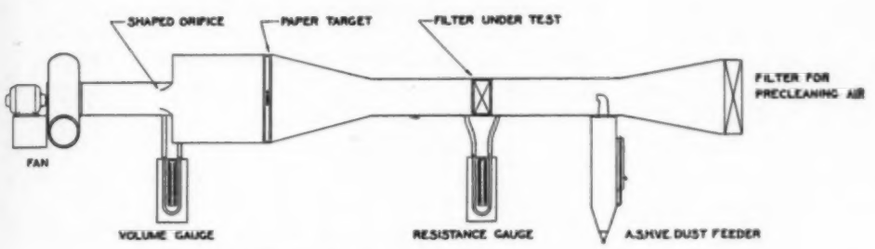

Fig. 1 — Diagram of test apparatus for collecting dust sample and measuring resistance and air volume

It is the purpose of this paper to explain a simple method of determining the arrestance of an air filter. The procedure on which this method is based is not new and has been used in one form or another in many laboratories. To describe the apparatus, reference is made to Fig. 1.

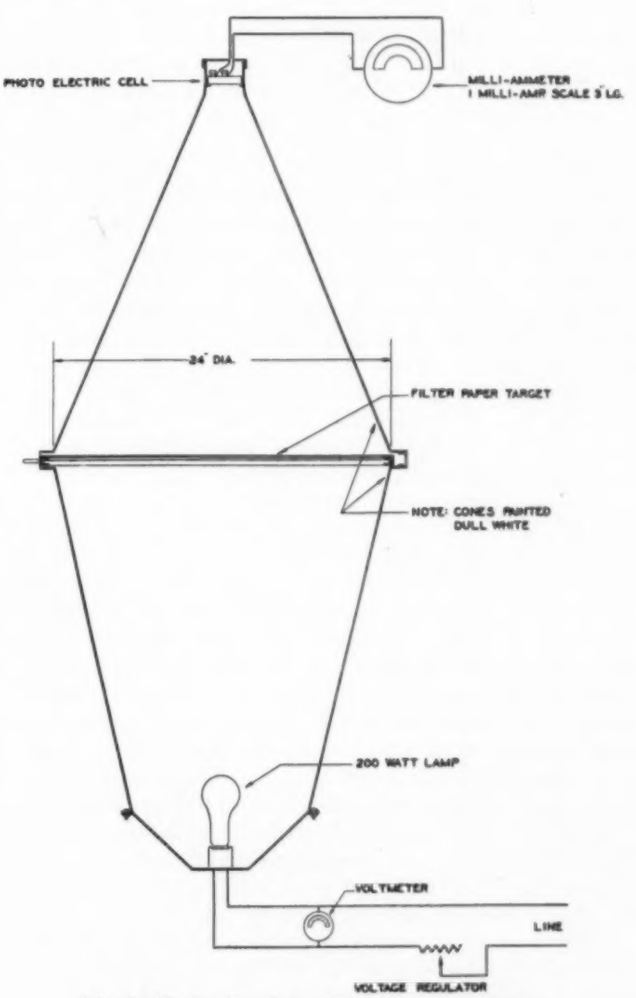

Fig. 2—Device for determining dust arrestance

*Chief Research Engr., American Air Filter Co., Inc.
Presented at the Semi-Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Swampscott, Mass., June, 1937.

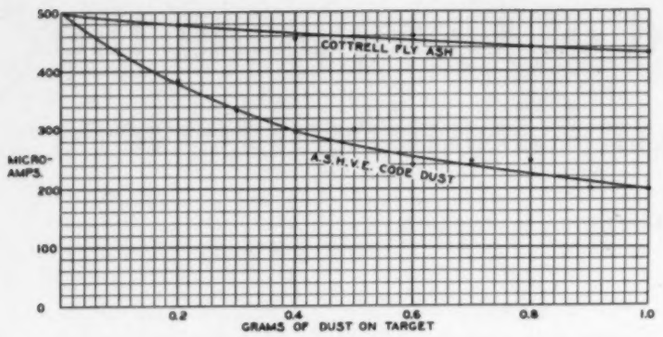

Fig. 3—Calibration curves with standard dust and fly ash

Air is first passed through a precleaning filter to free it of any impurities existing in the laboratory. Behind this filter a standard feeder, as described in the A.S.H.V.E. Code, introduces a known weight of dust to the air stream at the prescribed rate of feed described by that Code. The dusty air is then drawn through the filter under test and finally through a paper filter target located immediately behind the test filter. The purpose of the paper target is to extract as much as possible of the dust which passes through the filter. The typical methods of measuring resistance and air volume are illustrated in Fig. 1.

When all the dust has been introduced into the test filter, the paper target is removed and placed in the device illustrated in Fig. 2. This device consists of two sheet metal cones mounted with their bases adjacent and arranged so that the paper target can easily be placed between them. At the apex of the lower cone a source of light is mounted and at the apex of the upper cone there is mounted a photo-electric cell. Light passing through the dirty paper target and striking the photo-electric cell will generate a current inversely proportional to the weight of dust on the paper target. If previously a calibration has been made plotting the generated current from the cell against a known weight of dust on the paper target, then it is a simple matter to determine any unknown weight of dust by reference to the calibration curve. When the type of dust is changed, new curves must be made because of the variable light absorption properties of different dust.

Fig. 3 illustrates two calibration curves made with A.S.H.V.E. Standard Code dust and also using fly ash screened through a 325 mesh sieve.

When using this method of testing filter arrestance, the weight of dust passing through a filter can be determined by a single reading of the milli-ammeter. Furthermore, the arrestance can be obtained with a relatively small amount of dust fed to the filter instead of the usual 8 or 10 grams required when using a porcelain crucible and sampling tube. This permits feeding the dust very slowly, more nearly approaching the dust concentration actually encountered in practical use. The present Code recommends a rate of feed approximately 600 times as heavy as average conditions. In the previously described method of test this rate of feed could be reduced to 100 times average conditions.

One of the chief advantages of this method is that the paper targets can be preserved for future reference. The targets can be visually compared and with the naked eye it is possible to estimate a filter efficiency within 3 per cent. Many of the errors possible with the sampling tube method are largely eliminated by use of the paper target, chiefly because all of the air and dust from the test filter is passed through the target instead of a fractional percentage. One disadvantage of the target method is that some of the dust may pass through the target, but this is somewhat offset by the fact that when the calibration curve is made, the same quantity of the dust is also lost and the error is balanced. A further disadvantage is that care must be taken that too much dust is not allowed to reach the target, because when dust particles pile one upon the other they act as one particle so far as light absorption is concerned, and error will result.

This method of testing filters has been used for approximately a year and repeated checks between it and the sampling method of the A.S.H.V.E. Standard Code indicate very close agreement when all the factors relative to the sampling tube are free from liable error.

Review of Handbook of Chemistry and Physics

Continuing the policy of the past, the 21st revised edition of the Handbook of Chemistry and Physics has recently been released under the editorial direction of Charles D. Hodgman, in collaboration with forty other outstanding contributors in this field.

The general features and scheme of arrangement which have received endorsement in former editions have been maintained. The aim throughout has been to present in condensed form as large an amount of accurate, reliable and authoritative information in the fields of chemistry and physics as was consistent with convenience in form and the possibility of wide utility and distribution. A larger portion of the tables has been compiled especially for this volume from various collections of data and from current journals.

Attempts have been made to include material on all branches of chemistry and physics and the closely allied sciences, which would be likely to find any extended use in the field. On the other hand, in order to retain the convenience of modern dimensions and at the same time allow for an actual growth due to an extension of knowledge in these sciences and logical additions along lines already developed, it has seemed necessary to exclude types of material of use only in highly specialized lines of work.

The handbook is leather bound, containing 2,023 pages, and is available through the Chemical Rubber Publishing Co., Cleveland, Ohio, at $6.00 per copy.

Air Conditioning Data Sheets

Engineers requiring pocket size tables and data on heating, ventilating, refrigerating and air conditioning will find the Lefax sheets of service.

Some of the available data sections are Flow of Air and Gases; Air Compressors, Pumps and Fans; Air Conditioning; Heating; Refrigerating; Properties of Fuels; Combustion, Furnaces and Equipment; Steam Tables and Charts; and Steam Flow.

In the section on Air Conditioning are separate sheets of Tables of Properties of Saturated Water Vapor, small size psychrometric charts with full explanation as to use and complete tables of air densities.

Data sheets may be obtained separately or in sections through Lefax, Inc., 9th & Sansom Sts., Philadelphia, Pa.

How Much Power Will an Air Conditioning System Use?

By Anson D. Marston* (*MEMBER*), Kansas City, Mo.

"HOW much will it cost to operate?" Whenever the installation of air conditioning is under consideration, this question is sure to arise. This is a logical question—one for which the profession should have a reasonable answer, but so far no satisfactory method has been developed for answering it.

For a number of years, the heating industry has had a satisfactory basis for estimating heating costs and for checking the operation of heating plants. By using degree days below 65 F, excellent results have been obtained, with benefit to everybody concerned. This paper will outline the results of an investigation undertaken in an effort to arrive at some similar basis for use in estimating the energy consumption of air conditioning plants. As will be shown, there was found a strong indication that the *degree days above* 65 *F* furnish an acceptable basis for such estimates.

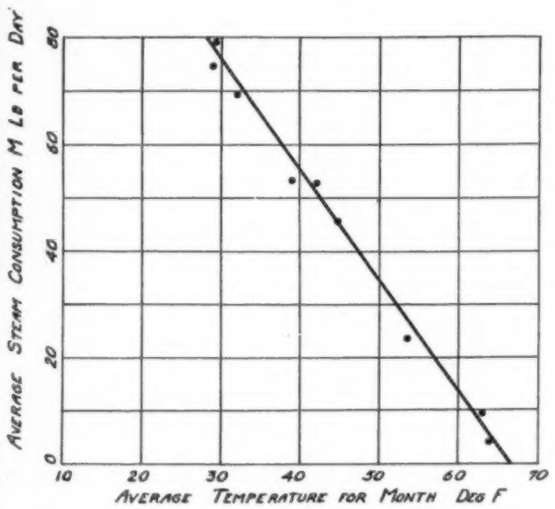

Fig. 1—Method of determining base temperature for degree-day calculations

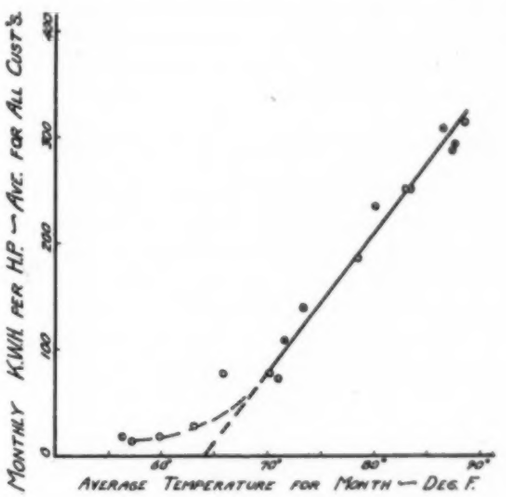

Fig. 2—Base temperature for degree-day calculations—summer cooling

One of the reasons why little information has been available on this subject is that comparatively few air conditioning plants were in operation prior to 1934. In view of the fact that accurate consumption records were kept for relatively few of the plants that were in operation, it is easy to understand why no general effort has been made to resolve the data available to some common denominator.

Theoretically it would seem improbable that the relationship between commonly furnished weather data and energy consumption would be close enough to be of value. The calculations necessary in determining the cooling load must take into consideration a number of items which are not included in heating problems and which are largely independent of weather conditions. Frequently the removal of heat and moisture, due to the presence of human beings, and of heat from special equipment such as lights and appliances, is a major part of the work to be done by a cooling plant. Obviously this must be done regardless of the weather. Sun effect is another important item whose magnitude is largely independent of temperature and humidity readings.

It must be remembered, however, that in a large majority of the smaller sized air conditioning installations, operation in practice is based upon temperature, without much regard to humidity. Few installations having a capacity of 20 tons or less are provided with any form of humidity control. In a large majority of cases, these installations are operated by people who watch the thermometer and who neither understand nor watch the relative humidity. Consequently, it appeared when these investigations were begun that temperature relationships were worth investigating.

Beginning in 1933, the Kansas City Power & Light Co. offered to its customers an optional rate for power used by strictly air conditioning equipment. This rate involves the use of a separate meter to measure the power used by such equipment. Furthermore this is an optional rate: wherever any other rate is more economical, the consumption for cooling purposes is billed on the other rate.

Of special importance in this study is the fact that

*Air Conditioning Division, Kansas City Power & Light Co.
Presented at the Semi-Annual Meeting of the American Society of Heating and Ventilating Engineers, Swampscott, Mass., June, 1937.

Table 1—Electrical Energy Consumption of Air Conditioning Customers—Kansas City Power & Light Co.

Month	Summary							
	1934		1935			1936		
	Average of Kwhr per Hp		Average of Kwhr per Hp			Average of Kwhr per Hp		
	All Cust's.	Comm'l. Cust's.	All Cust's.	Res. Cust's.	Comm'l. Cust's.	All Cust's.	Res. Cust's.	Comm'l Cust's.
May...	156	184	18	0	23	72	14	101
June...	250	265	109	71	119	185	125	211
July...	313	314	307	270	318	294	260	311
August.	250	253	234	208	242	286	243	307
Sept...	78	80	78	47	88	138	96	158
Oct....	29	31	19	3	24	15	1	21
Totals	1,076	1,127	765	599	814	990	739	1,109

this rate calls for customers to be disconnected on October 15 of each year and reconnected on May 1 of the following year. Consequently, fans and other equipment, which are to be used during the winter, are usually served under one of the other rate schedules.

During the period from 1934 to 1936 inclusive, a total of 72 customers operated under this rate for periods long enough to be of value in this study. Many of these furnish records covering a part only of this period. However, enough information is available for each of these three years to serve as a basis for close study of the relationship between power consumption and weather. The records obtained from these customers are summarized in Table 1.

Method of Determining a Degree Day Base

On pages 523 to 528 of The A. S. H. V. E. Guide, 1937, will be found a discussion of the methods used in determining the base temperature for degree day calculations for the heating season. Briefly the base temperature was selected originally by plotting average steam consumption against average monthly temperatures. Points plotted in this manner fall close to a straight line and indicate that consumption is directly proportional to the difference between 65 F and the average temperature. Fig. 1 is reproduced from page 527 in The Guide 1937, which illustrates the manner in which this was done.

In the 1932 Proceedings of the *National District Heating Association* there is reported a study of the

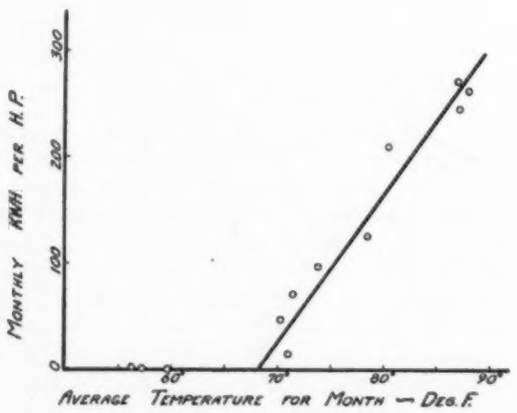

Fig. 3—Effect of temperature on energy usage average for all residences

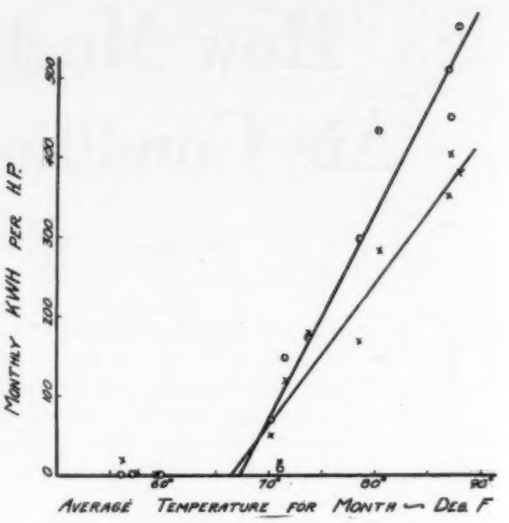

Fig. 4—Effect of temperature on energy usage—two typical residences

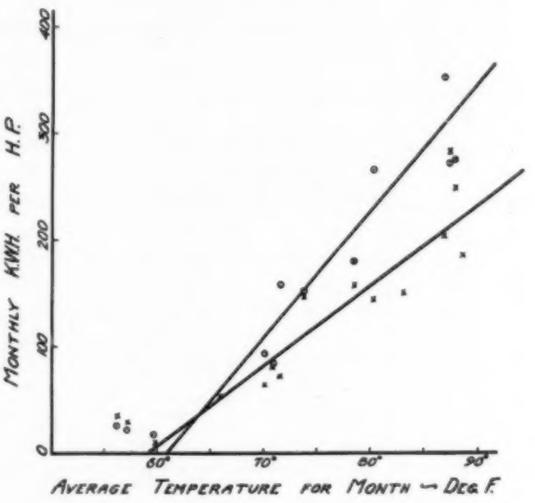

Fig. 5—Effect of temperature on energy usage—two typical offices

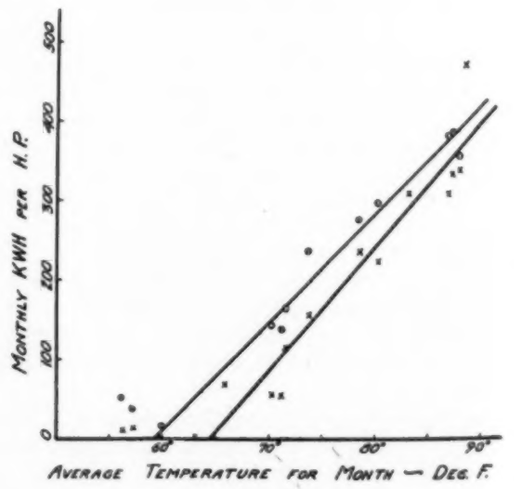

Fig. 6—Effect of temperature on energy usage—two typical restaurants

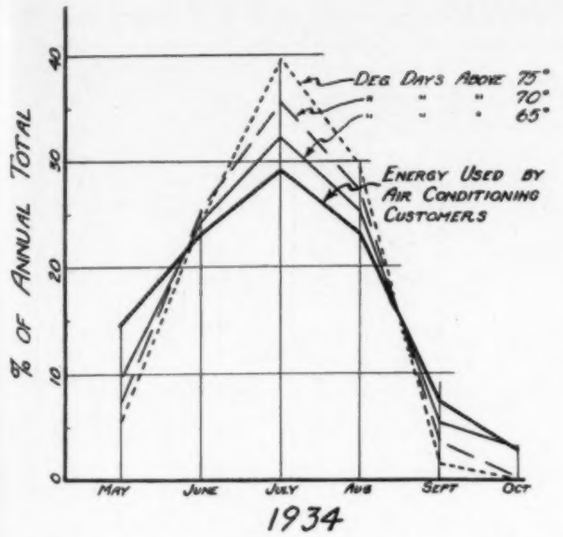

Fig. 7—Monthly variation in degree days and in power used by air conditioning customers, Kansas City, Mo.

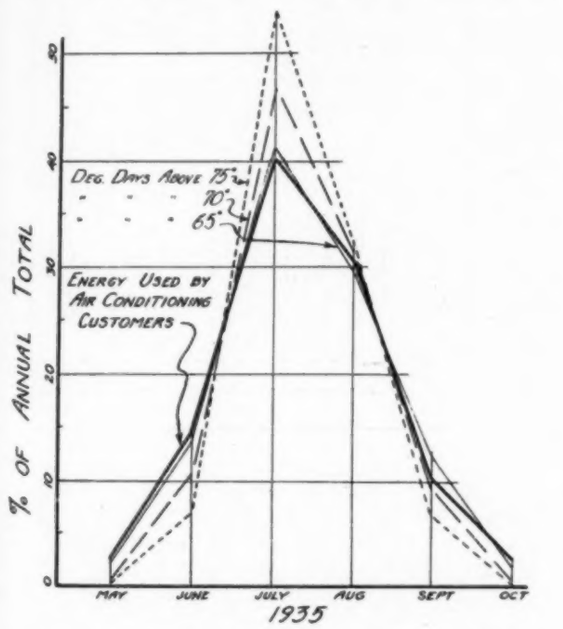

Fig. 8—Monthly variation in degree days and in power used by air conditioning plants, Kansas City, Mo.

steam consumption of 163 buildings. These were divided into 20 classes, depending upon usage, and the base temperature corresponding to zero steam consumption was determined for each class. These base temperatures vary from 61.2 F for auto sales and service buildings to 68.8 F for apartments. The average is 66.0 F for all buildings. However, in spite of this variation, it is found in practice to be satisfactory to use the 65 F base for all classes of buildings.

Similar investigations were made using the summer energy consumption data summarized in Table 1. Fig. 2 shows the relation existing between average monthly temperatures and the average energy consumption for all classes of customers. A study of this chart will show that the consumption is substantially proportional to the difference between 65 F and the average monthly temperature. However, the figures for those months with

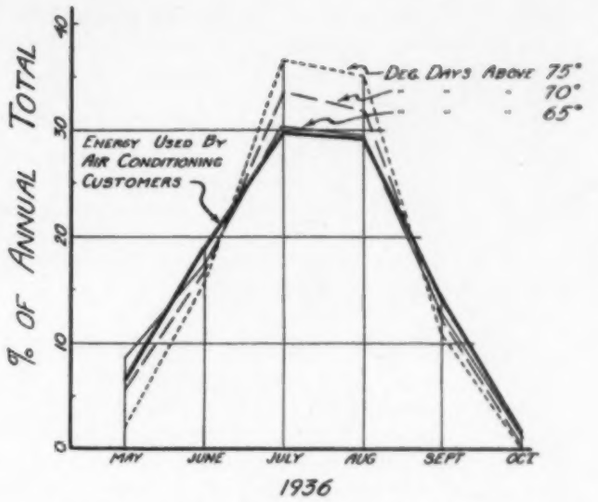

Fig. 9—Monthly variation in degree days and in power used by air conditioning plants, Kansas City, Mo.

average temperatures below 65 F deviate considerably from this relationship. This is to be expected, because many months with low average temperature contain periods of a week or more of hot weather with consequent use of cooling equipment. For example, September 1934 had an average temperature of 65.8 F, although it contained seven days with maximum temperatures of 85 F or higher.

The same information for residential customers is shown in Fig. 3. It will be noted that the base temperature for residential customers appears to be 68 F.

As a further check on the relation between temperature and energy usage, Figs. 4, 5, and 6 were drawn. Fig. 4 shows the temperature relationship for two typical residences; Fig. 5 shows the data for two typical offices; and Fig. 6 shows the same information for two typical restaurants. Similar curves have been drawn for other customers and they indicate, in each case, a close relationship between average monthly temperature and energy consumption. Customers whose load is primarily determined by weather conditions—residences for example—have base temperatures above 65 F, while customers having a large proportion of their load independent of weather conditions generally have base temperatures below 65 F.

Additional Studies of Base Temperatures

When this study was started, it was expected that the base temperature would be between 70 F and 75 F. When an indicated base of 65 F was found, it was felt that additional studies should be undertaken as a verification. As a result of these studies, Figs. 7, 8, and 9 were drawn. In these figures the per cent of total annual energy consumption occurring during each month of the cooling season is plotted for each year. In the same figures is shown, for each month, the per cent of the total annual number of *degree days above* 65 *F, above* 70 *F, and above* 75 *F.*

A study of these figures will show two things. First, that the variation in energy consumption follows closely the variation in *degree days above* 65 *F.* The agreement for 1934 is poor, but that for 1935 and 1936 is excellent.

Possibly this may be caused by the fact that relatively few customers were operating under this rate in 1934, and consequently the figures for this year can not be considered conclusive.

In the second place, these figures indicate quite clearly that *degree days above* 65 *F* give much closer agreement than do degree days calculated from other base temperatures. As an additional check, similar curves were drawn to a large scale and the degree days for intermediate temperature bases were included. These additional curves verify the use of 65 F as a base.

No Traceable Relationship With Relative Humidities

The important factor of relative humidity has been neglected entirely in the above investigations. Before proceeding with the use of 65 F as a base, it was considered necessary to investigate the effect of relative humidity. Table 2 has been compiled from U. S. Weather Bureau records and shows the number of days each year during which the outside wet-bulb temperature equalled or exceeded various values.

A comparison of Table 2 with Table 1 indicates the absence of any direct traceable relationship. For example, in 1934 there were 21 days with 75 F wet-bulb temperatures or higher. In 1935 there were 39, and in 1936, 24 such days. When a wet-bulb temperature of 67 F is considered, the figures are 96 in 1934, 90 in 1935, and 102 in 1936. The energy consumption for commercial customers was 1,127 kwhr per horsepower for 1934, 814 in 1935, and 1,109 in 1936. These figures indicate the absence of any well-defined relationship between relative humidity and energy consumption.

Degree Days vs. Energy Consumption

Table 3 has been compiled from the records of the U. S. Weather Bureau, and indicates that, for Kansas City, the normal number of *degree days above* 65 *F* is 1,465. It will be noticed that there has been a variation from 946 in 1915 to 2,334 in 1936. Incidentally, the average for the past 10 years is 1,632, or 11.4 per cent above the 47 year average.

Table 2—Days Wet-Bulb Temperatures Were Equalled or Exceeded May 1 to October 15 Inclusive, Kansas City, Mo. (Highest of 7 A. M., Noon, and 7 P. M. Readings)

Wet-Bulb Temp.	No. Days Equ. or Exc. Wet-Bulb Temp.		
	1934	1935	1936
80	.....	3	.....
79	.....	6	.....
78	.....	12	2
77	8	20	2
76	14	32	10
75	21	39	24
74	32	46	43
73	44	51	54
72	53	59	67
71	70	66	72
70	78	75	78
69	85	82	86
68	91	85	92
67	96	90	102
66	99	97	108
65	109	104	116
64	112	106	119
63	120	108	120
62	127	112	124
61	134	114	132
60	137	119	139

Table 3—Degree Days Above 65 F, Kansas City, Mo.

Year	May No. Days	June No. Days	July No. Days	August No. Days	September No. Days	October No. Days	Annual Total
1890	75	363	481	268	81	21	1,289
1891	336	220	230	276	215	40	1,017
1892	28	306	339	359	172	52	1,256
1893	48	245	393	264	254	59	1,263
1894	99	300	363	410	173	52	1,397
1895	131	242	290	322	308	0	1,293
1896	169	241	385	390	100	12	1,297
1897	79	322	478	309	368	103	1,659
1898	102	331	379	368	240	43	1,463
1899	124	282	346	446	174	113	1,485
1900	122	270	378	470	231	81	1,552
1901	66	418	683	440	190	46	1,843
1902	174	182	390	349	47	32	1,174
1903	84	155	424	309	130	25	1,127
1904	52	188	306	285	202	39	1,072
1905	60	311	290	411	184	42	1,298
1906	147	254	327	393	239	13	1,373
1907	58	219	419	367	157	15	1,235
1908	140	205	351	332	261	34	1,323
1909	52	252	397	481	160	68	1,410
1910	30	240	429	323	158	76	1,256
1911	224	469	443	404	268	24	1,832
1912	179	187	461	380	204	33	1,444
1913	120	349	512	633	205	58	1,877
1914	138	406	488	410	186	38	1,666
1915	82	163	299	183	190	29	946
1916	123	181	569	437	157	46	1,513
1917	40	250	462	257	154	20	1,183
1918	173	451	424	577	70	58	1,753
1919	56	329	524	358	234	53	1,554
1920	74	255	368	268	203	71	1,239
1921	187	363	498	372	260	29	1,709
1922	87	377	373	422	240	68	1,567
1923	63	274	445	389	154	5	1,330
1924	29	227	302	412	74	76	1,120
1925	93	347	423	409	324	21	1,617
1926	163	231	431	435	204	19	1,483
1927	83	191	372	207	278	71	1,202
1928	132	172	418	384	123	91	1,280
1929	72	246	421	412	146	20	1,317
1930	81	256	550	474	232	65	1,658
1931	87	438	519	344	385	85	1,858
1932	126	347	507	422	146	25	1,573
1933	124	507	491	344	336	19	1,821
1934	221	545	721	568	122	62	2,239
1935	36	220	675	483	199	31	1,644
1936	203	406	706	680	304	35	2,334
Totals	4,872	13,693	20,480	18,236	9,442	2,118	68,841
Avg...	104	291	436	388	201	45	1,465

The relation between average energy consumption for all customers and *degree days above* 65 *F* is given in Fig. 10. From this figure it will be noticed that there is a surprisingly good relation between these two figures where a large group of customers is considered. In order

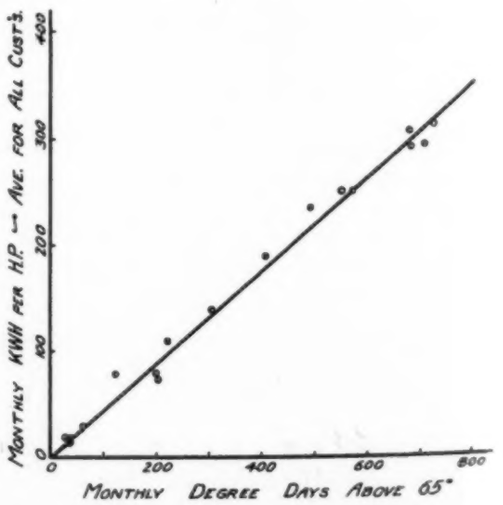

Fig. 10—Energy consumption vs degree days

Table 4—Energy Consumption—Air Conditioning, Kansas City, Mo.

Month	Normal Deg Days Above 65 F	Normal Kwhr per Hp	Normal Per Cent of Annual Total
May	104	51	7.4
June	291	137	19.9
July	436	201	29.2
August	388	180	26.1
September	201	97	14.1
October	45	23	3.3
Totals	1,465	689	100.0

to determine the effect of taking a limited group of customers, Fig. 11a was drawn, using the average consumption of residential customers. In this case the agreement is not as satisfactory, for a line drawn through the points indicates zero consumption for a month with 100 *degree days above* 65 *F*. Figs. 11b and 11c show the same data for *degree days above* 68 *F*, and *degree days above* 70 *F*. From these figures it appears that *degree days above* 70 *F* give better results when residential customers are only considered. For two reasons, however, this can not be considered as conclusive. In the first place, the number of residences operating more than a year is rather limited. In the second place, those customers who can afford cooling for their homes are in the habit of taking extended summer vacations, during which no cooling is used. This was done in enough cases to throw doubt upon any final conclusions drawn at this time.

Fig. 12 shows that, where commercial customers only are considered, values for *degree days above* 65 *F* can be used with assurance. This is borne out by Figs. 13 and 14, which show the same data for restaurants and for offices and banks.

From Fig. 10 and Table 3, it is possible to determine the normal energy consumption to be expected each month from a sizable group of air conditioning customers. This information is shown in Table 4, which indicates that a total of 689 kwhr per horsepower can be expected. The distribution of this consumption among the summer months is shown by the last column of Table 4.

Effect of Hours of Operation

The information given in Table 4 is of value to a utility estimating the revenue to be expected from a large and representative group of air conditioning customers. However, it does not give the answer to an engineer desiring to tell one particular customer what will be his operating costs.

In an effort to arrive at values which take into account the class of operation or the hours of operation, Fig. 15 was drawn. In determining the data for this figure, the average number of kilowatt hours per horsepower consumed during 1936 by those customers operating 720 hours a month (24 hours a day) was calculated and shown as one point. Similar points are shown for other classes of operation. Mention should be made of the fact that there are two customers operating 540 hours per month whose operations deviate widely from that of all others. These two have been ignored in drawing Fig. 15.

Through the points determined in this manner was drawn a line showing for 1936 the relationship between

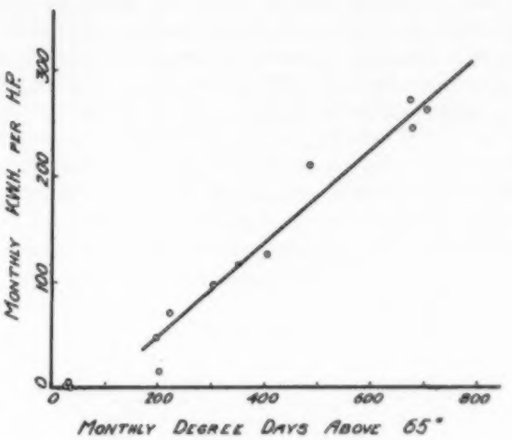

Fig. 11a—Energy consumption vs degree days above 65 F—residences

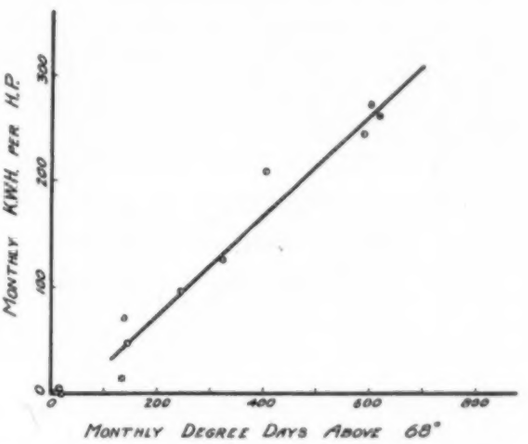

Fig. 11b—Energy consumption vs degree days above 68 F—residences

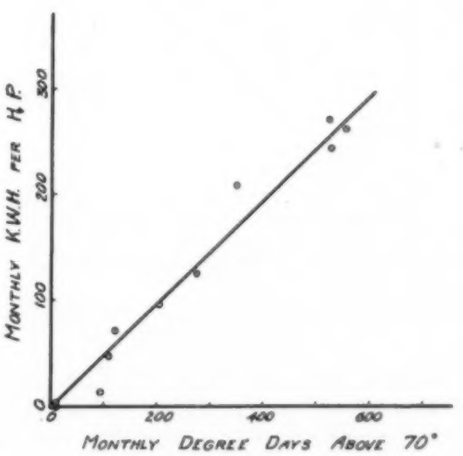

Fig. 11c—Energy consumption vs degree days above 70 F—residences

hours of operation and annual energy consumption. A similar line was drawn for 1935. Then these two were adjusted to a normal year in accordance with variations from the normal number of *degree days above* 65 *F*. The line labeled *Adjusted to Normal Year* is the result.

Table 5 lists in tabular form the points on this line. With this table it is possible to estimate with reasonable accuracy the total annual consumption which any given commercial customer should experience in a normal year.

In using Table 5, it is important to bear in mind the fact that it is based upon the assumption that the cooling plant has been correctly designed. Naturally any deviation from accepted design standards will affect the energy consumption. As an example, in 1935 one restaurant operating 18 hours per day installed a 3-ton

Table 5—Energy Consumption vs Hours Open Per Month Based on *Normal* Year, Kansas City, Mo.[a]

Hours Open per Month	Kwhr per Hp per Year	Hours Actual Operation per Year (1 Hp = 0.9 Kw)
720	1,200	1,332
660	1,120	1,120
600	1,050	1,165
540	975	1,083
480	895	994
420	820	911
360	745	828
300	670	744
240	590	656
200	540	600

[a]Compiled by the Kansas City Power & Light Co.

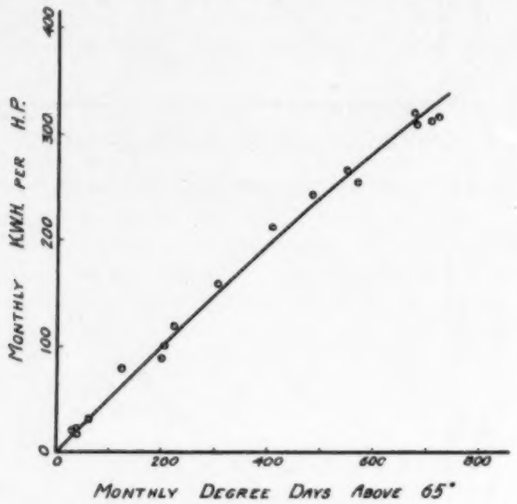

Fig. 12—Energy consumption vs degree days above 65 F—commercial customers

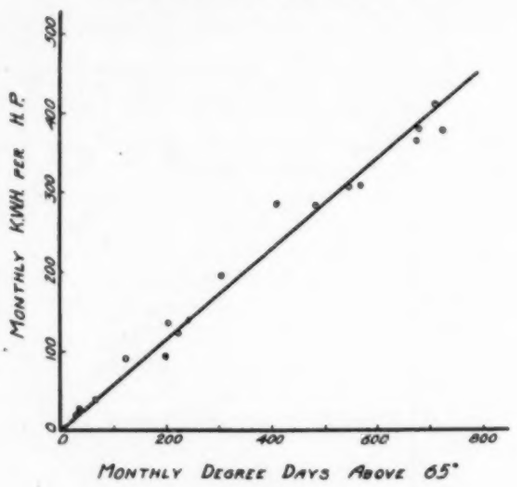

Fig. 13—Energy consumption vs degree days above 65 F—restaurants

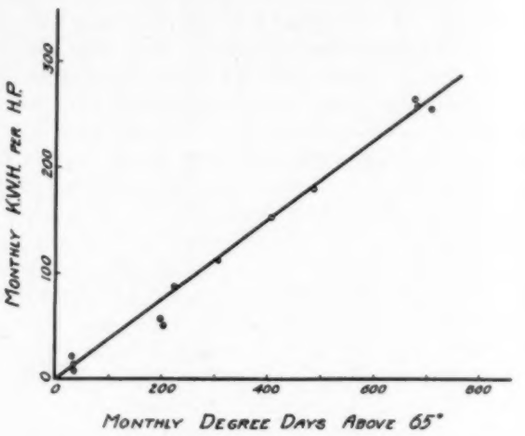

Fig. 14—Energy consumption vs degree days above 65 F—offices and banks

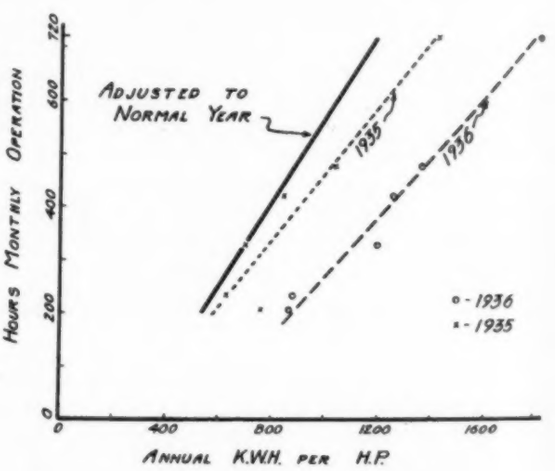

Fig. 15—Energy consumption vs hours of operation

compressor, although the calculated heat gain was 7½ tons. From July 4 to August 4, this compressor used 780 kwhr per horsepower—indicating that the motor ran 24 hours per day. This installation was later removed because it was unsatisfactory. As another example, a large downtown restaurant installed 75 hp in 1935. The management of this restaurant insisted on a design that was unnecessarily liberal. During 1935 the energy consumed by this equipment was only 334 kwhr per horsepower—less than half the normal value. This restaurant operates 10 hours per day.

Mention should be made again of the fact that these data cover the operation of equipment which is used only for summer cooling. No attempt was made to include the operation of fans which are used for year-round air conditioning, although a number of fans used only in the summer months are included. Several of the installations studied have evaporative condensers or cooling towers connected on the same meter as the compressor. Where this was done, it appears that the energy consumption per horsepower for such equipment was substantially the same as that for the balance of the load.

As an example of the use of the information gathered

in this investigation, assume that the proprietor of a restaurant operating 300 hours per month desires to know the approximate energy consumption of a 20 hp installation which will be used during summer months only.

From Table 5, it is noted that the total energy consumption should be 20 hp × 670 kwhr or 13,400 kwhr. By referring to Table 4, it is noted that this should be distributed through the year as follows:

May	7.4 per cent × 13,400	990 kwhr
June	19.9 per cent × 13,400	2,665 kwhr
July	29.2 per cent × 13,400	3,915 kwhr
August	26.1 per cent × 13,400	3,500 kwhr
September	14.1 per cent × 13,400	1,890 kwhr
October	3.3 per cent × 13,400	440 kwhr
Total		13,400 kwhr

Conclusions

In conclusion it is felt that the investigation described previously indicates the existence of a close relationship between the energy consumption of summer cooling installations and the *degree days above* 65 *F*. There are some indications that *degree days above* 70 *F* furnish a better basis for estimates of energy consumption for residences, but these are not conclusive. It is realized that the information set forth herein applies only to Kansas City, Mo.

The officials of the Kansas City office of the U. S. Weather Bureau have shown a fine cooperative spirit and have indicated their willingness to publish values on *degree days above* 65 *F* as soon as there is sufficient justification for using this particular temperature. The Washington, D. C., office of the U. S. Weather Bureau has adopted the policy that wide spread publication of such values must wait until all investigative studies have been completed and agreement obtained.

Before this relationship can be considered sufficiently established to justify widespread use, additional studies must be undertaken in other parts of the country. In view of the many uses to which this relationship can be applied when once established, it appears that these additional studies should be undertaken without delay. Electric utilities, manufacturers and their distributors, and consulting engineers have all shown an intense interest in the results obtained to date.

In the Kansas City area they are already using them in preparing estimates of operating cost.

Employment in the Engineering Profession

An analysis has been released by the Bureau of Labor Statistics covering reports from 52,589 professional engineers, showing the kinds of employment engaged in over a period from 1929 to 1934.

One of the most important phases of this analysis indicates that over this period of time there was a substantial net loss of employment by engineers who were active before 1935 and a considerable absorption of employment of newcomers to the profession. The net result for the five-year period ending December 1934 was an increase of 25.3 per cent in the number of persons in the engineering profession. This rate of increase was much in excess of the available engineering opportunities. The fact that available engineering opportunities did not keep pace with the increase in the number of men trained to enter the profession brought about changes in the proportions of those who were unemployed or engaged in non-engineering work.

Non-engineering employment increased sharply from 1929 to 1932 and in equal measure for all professional classes, absorbing many more engineers than did public engineering in which employment also increased. But despite the fact that the proportions of all engineers in non-engineering employment rose from 6.3 per cent in 1929 to 12 per cent in 1932, there was an even larger increase in unemployment. This situation was common to all professional classes.

Between December 1932 and December 1934 there were further increases in non-engineering employment for all professional classes, but the increases were not as great as between 1929 and 1932. It was evident from these studies that unemployment declined for all professional classes except for civil engineers.

Of all the engineers who reported as being professionally active prior to 1930, only 46.2 per cent were in the employ of private firms in 1934, while in 1929 there were 62.2 per cent so engaged. Federal government employment provided for 10.1 per cent in December 1934 and in 1929 this field gave employment to only 5.3 per cent.

Over the period of 1930-1934 there was a remarkable stability in the number of engineers classified as independent consultants and those engineers engaged in the teaching of engineering subjects. This was also true in the case of those employed by state and county and municipal and other public authorities, especially when considered together.

The net new private firm employment that developed between 1930 and 1934 was secured by newcomers who entered the profession in this period. In absolute number, 5,003 or 16 per cent of the engineers active in the profession before 1930 suffered loss of engineering employment. Some 3,112 or 18 per cent of the new entrants found engineering work with private firms. The increase in public engineering employment was shared by both older and younger engineers.

Axial-Flow Fans

The Theory and Performance of Axial-Flow Fans, translated by L. S. Marks with the assistance of J. R. Weske, is based on an original dissertation, prepared by Curt Keller of Escher Wyss Laboratories, Zurich, Switzerland.

The book is intended to be of value to the designer of an axial-flow fan unit consisting of the inlet, guide vanes, fan wheel and diffuser. A classification of axial-flow fans on the basis of a dimensionless characteristic number is presented and is utilized in establishing the general design of a fan through a series of tables and graphs.

One of the principal contributions of this volume is contained in a compilation of performance data for a series of axial-flow fans having from 4 to 20 blades.

This book comprises 140 pages, is cloth bound and available through the publishers, McGraw-Hill Book Co., Inc., New York, for $4.00 per copy.

Pittsburgh Experiment Station of the U. S. Bureau of Mines where the Research Laboratory of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS *is located*

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*Member of Committee on Research.

A. S. H. V. E. RESEARCH

A Page of News Notes and Comment

By Brewster S. Beach*

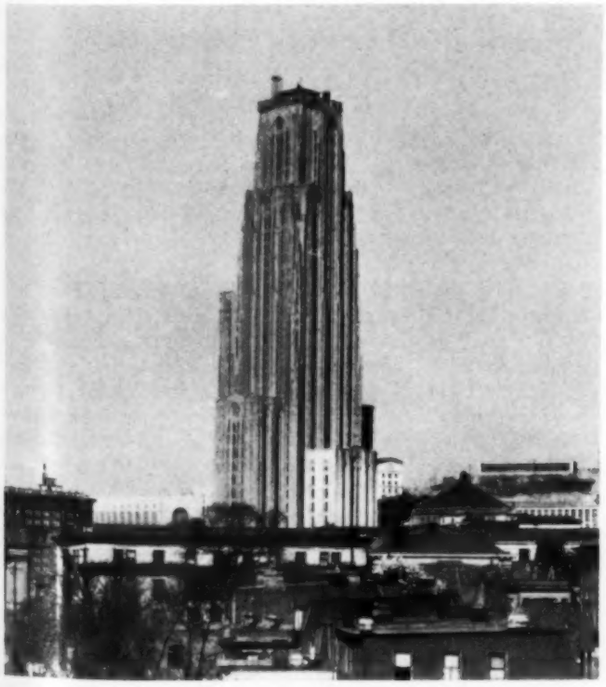
NEW HOSPITAL STUDY LAUNCHED BY A. S. H. V. E.

Another important step in the study of the effect of air conditioning on the treatment of disease has been recently launched between the A.S.H.V.E. laboratory and the University of Pittsburgh which will enlist the cooperative effort and joint interest of the surgeon, physiologist, bacteriologist and air conditioning engineer. The investigation includes work in the Magee Hospital of that city as well as the medical school of the university which is part of the famous Cathedral of Learning.

Plans are being completed for equipping an operating room and an adjoining recovery ward with an experimental air conditioning system with which atmospheric conditions of varying temperature, humidity, air movement and air supply can be studied, together with the most advanced means of eliminating dust and bacteria.

Those carrying on the studies from the medical viewpoint are: Dr. W. S. McEllroy, assistant dean of the Medical School; Dr. T. L. Hazlett and Dr. M. B. Ferderber, representing the university and A. M. Scaife, member of the board, and Miss Turnbull, superintendent, representing the Magee Hospital.

G. S. McEllroy, and Prof. C. M. Humphreys of the Pittsburgh Chapter, A.S.H.V.E., and F. C. Houghten of the research laboratory will represent the air conditioning interests.



Cathedral of Learning, University of Pittsburgh, where A.S.H.V.E. hospital air conditioning studies will be centered

*Director, Information Service, Committee on Research.

DR. FIELDNER JOINS RESEARCH COMMITTEE

Dr. Fieldner

Dr. A. C. Fieldner, who is well known to many A.S.H.V.E. members and has in the past cooperated in Society research, has become ex-officio member of the Committee on Research, succeeding Dr. O. P. Hood, lately deceased.

Dr. Fieldner is chief of the Technologic Branch of the United States Bureau of Mines, Department of the Interior, with headquarters in Washington, D. C. He is a graduate of the Ohio Wesleyan University and Ohio State University and has been with the Bureau of Mines since its formation in 1910.

Dr. Fieldner was in charge of the research on ventilation in connection with the Hudson River vehicular tunnel and was co-author of a paper on this subject which appeared in the A.S.H.V.E. JOURNAL in 1926.

RECOMMENDATIONS FOR NEW SOCIETY RESEARCH

Among the recommendations contained in a second-quarter report of research progress, submitted by F. C. Houghten of the research laboratory at the meeting of the Committee on Research at Swampscott, were studies to be undertaken by the Society to determine the practical possibilities of the super-sonic method of air cleaning and the electrostatic method of precipitating dust.

"The super-sonic method of air cleaning as now fostered by the United States Bureau of Mines," said Mr. Houghten, "offers certain unique possibilities. There are, however, wide differences of opinion regarding the feasibility of using it in air cleaning problems and the suggestion has therefore been made that our laboratory cooperate with the Bureau of Mines to definitely establish or reject these possibilities."

TRANSPORTATION AIR CONDITIONING COMMITTEE NAMED

Announcement has been made by Chairman W. A. Danielson of the Committee on Research of the appointment of the following commitee to be known as the Committee on Transportation Air Conditioning:

L. B. Miller, New York, *chairman;* L. W. Wallace, *Association of American Railroads,* Chicago; R. T. Crowder of the Pullman Company, Chicago, and Prof. Frank B. Rowley, Department of Mechanical Engineering, University of Minnesota, Minneapolis.

Appointment of an official technical advisory committee to study these problems was foreshadowed in the report on railroad air conditioning contained in last month's research news page.

Correlating Thermal Research

As a part of the efforts of the A. S. H. V. E. Research Laboratory to correlate research in thermal engineering carried on by the many institutions engaged in such work, and to disseminate the published results of such studies together with other reports of progress in the field, and in order to make this information available to the membership of the Society, there will be published monthly on this page a limited number of brief abstracts of articles which it is believed will be of interest to all concerned. For more complete lists address the Librarian, A. S. H. V. E. Research Laboratory, U. S. Bureau of Mines Experiment Station, Pittsburgh, Pa.

F. C. Houghten, *Director.*

W. A. Danielson, *Chairman,*
COMMITTEE ON RESEARCH

• What the Management Can Do to Prevent Silicosis. *Concrete,* vol. 45, no. 6, June 1937, pp. 185-186. National conference committees give 14 measures employers should take to eliminate this hazard.

• Air Conditioning the Buffalo General Electric Office Building, by J. T. Scanlan. *National Engineer,* vol. 40, no. 6, June 1937, pp. 328-330. Description of complete system of air conditioning in the 12-story office building of the Buffalo General Electric Co. Unusual arrangement of ducts and other equipment for distribution of air. Zone system used with floor and ceiling air conditioning units. Diagram of duct system.

• Sixty-three Individual Ducts Serve Air Conditioned Spaces in Windowless Building, by Robert E. Hattis. *Heating and Ventilating,* vol. 34, no. 6, June 1937, pp. 31-34. Description of air conditioning system installed in new building of the National Aluminate Corp. near Chicago. It is a two-story windowless, white terra cotta building. Air conditioning system is made of two separate units; each section of building is conditioned by separate duct system with cooling or heating unit. Diagram of duct system.

•Latent Energy in Combustion, by Prof. W. T. David. *Philosophical Magazine (S. 7),* vol. 23, no. 154, March 1937, 2A, Article XXXV, pp. 345-355. Paper suggests that during the passage of flame through an inflammable gaseous mixture there is formed in the flame front a very stable form of latent energy which remains in the flame gases left behind. It is probable that the latent energy resides in metastable molecules which result from the reaction in the flame front. Theory evolved from study during last 7 years in intensity and duration of afterglow in flame gases, continuous pressure and heat loss measurements during explosion and subsequent cooling of inflammable gaseous mixture in closed vessels. Latent energies vary from 1 to 25 per cent of the heat of combustion in flames burning at constant pressure.

• Modern Forms of Water-tube Boilers for Land and Marine Use, by Dr. Frederich Munzinger. *Proceedings of the Institute of Mechanical Engineers,* vol. 134, 1936, pp. 5-87. Discussion of new designs in water-tube boilers. Main changes since 1920 are pulverized-fuel firing, increase in steam pressure and temperatures, the heating of feed water by bled steam and use of chemically treated feed-water. Paper has diagrams of boiler construction, mainly of new German types.

• Air Conditioning for Railroads. *Ice and Refrigeration,* vol. 92, no. 6, June 1937, pp. 421-422. Discussion of Summary Report on Air Conditioning of Railroad Passenger Cars by the Division of Equipment Research, *Association of American Railroads.*

• The Smoke of Cities, by J. S. Owens. *Proceedings of the Institute of Mechanical Engineers,* (London), vol. 134, 1936, pp. 211-275. Methods used and data obtained during 25 years study of pollution of air by smoke. Discussion of problems of smoke pollution and health, ventilation and cost of smoke, height of chimneys, and trapping of flue dust. Deals with measuring of smoke and possible laws to regulate smoke production. Description and illustration of new instrument for measuring the optical density of smoke with a revolving vane. Method of fixing legal limits for smoke emission is described.

• Health and Safety of Industrial Workers. *Nature,* (London), vol. 139, no. 3525, May 1937, pp. 857-859. Discussion of Factory Act of 1901 and the possibility of Parliament passing a new act for the regulation of industry which should emphasize the relation of industry and health. Outlines the need of physician's care in all factories.

• New Process to Make Dry-ice from Factory Flue Gas. *Ice and Refrigeration,* vol. 92, no. 6, June 1937, pp. 395-6. New chemical process of recovering carbon dioxide from flue gas. This process overcomes alkali carbonate absorption. Recovery of carbon dioxide from power plant flues is feasible at low cost and the product is pure for all exacting requirements.

• New Heat-Transfer Units Simplify Air Conditioning, by Paul A. Sherer. *Power,* vol. 81, no. 5, May 1937, pp. 256-257. Description of air conditioning in pear storage warehouses. Brine-film air conditioning units in attic cool air and remove dust particles and fungus spores.

• Coal Dust and Other Fuels for Diesel Engines. *The Fuel Economists,* vol. XII, no. 140, May 1937, pp. 294-295. General review of development of the Diesel engine during 1936, with references to use of fuels other than petroleum. Fine coal dust or other solid fuel is used in specially developed Diesel motors. At present, most difficult problem is cylinder wear due to ash and coal particles passing between the pistons and the cylinder wall.

• Microscopic Study of Typical Italian Dusts, by L. Santarelli. *Ann. Chim. Applicata,* vol. 27, Jan. 3 and 14, 1937. Gallo in 1908 began study of Italian dusts. Few intervening dust studies to date. Study of dusts near Rome, Naples and Thessaly. Their crystalline structure enables identification with rock or their origin.

• Heat Insulation as Applied to Buildings and Structures, by E. A. Allcut and F. G. Ewens. *Bulletin No. 149,* 1937, Faculty of Applied Science and Engineering School of Research, University of Toronto, 57 pages; bibliography. Definition of heat transmission terms. Description of methods of testing heat conductivity of building materials. Data for several insulating materials.

• Report of the Building Research Board for the Year 1935. London. Paper 176 pages. H. M. Stationery Office, 1936. The work of the Board is largely concerned with the properties of building materials, and with structures and strengths of materials. Tests were made of the radiant efficiency of various types of panel radiators, thermal conductance of walls and air conductance of asbestos cement roofs. Differential thermopile for measurement of radiant heat is described. Report of experiments on exclusion of solar heat from thin roofed buildings.

• Ice Meltage Data in Refrigerating Car Test Shipments and a New Method for Determining the Same, by E. A. Gorman. *Ice and Refrigeration,* vol. XCII, no. 6, June 1937, pp. 387-389. Method of accurately determining the rate of ice meltage in refrigerator car during transit. Drip type meter used to measure water from melting ice.

• Atmospheric Cooling Equipment for Condenser Water, by Fred D. Mosher. *Heating and Ventilating,* vol. 34, no. 5, May 1937, pp. 40-44. Description of cooling equipment for spray ponds. Diagram of piping in spray pond. Tables of temperatures of water from atmospheric cooling in various states during summer, and summer wind velocities.

The Inspiration of Society Membership

In response to an invitation from R. C. Bolsinger, chairman of the Membership Committee, W. H. Carrier, Newark, N. J., has written his thoughts on, Why I Have Continued My Interest and Activities in the Society Long After I Have Held the Highest Honors the Society Can Bestow. This message comes appropriately from Mr. Carrier who was president of the A. S. H. V. E. in 1931 and received the first award of the F. Paul Anderson Medal in 1932.

W. H. Carrier

No young engineer electing to follow the profession of heating, ventilating and air conditioning can afford to miss the opportunities for personal development and technical advancement which the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS offers. Nor for that matter can the older and more experienced engineer—who may already have achieved distinction in his field—ignore the benefits that come with membership in our Society.

I say this in all sincerity because I have proof of it within my own experience. I count my membership in the A.S.H.V.E. as one of the soundest investments I ever made, for I have been able through it to cooperate with others whose common interest has lain in the development and expansion of air conditioning. I have profited both from the personal contacts and acquaintanceships that membership has brought to me, and by the privilege of taking counsel with others. Viewed from whatever angle one may choose, Society membership is a broadening influence, stimulating alike to the mind and the spirit—a necessary part of the equipment which every engineer requires to maintain his perspective and develop his talents to the utmost.

Success in engineering as well as in other professions, requires a comprehensive knowledge of the broad field, a familiarity with the processes of collective thought which actuate the development of an industry. Membership in a society such as the A.S.H.V.E. keeps one in touch with what is going on, stimulates constructive thinking, broadens one's outlook, makes one more valuable to society and his employer.

It often may become an avenue of sound advancement and a means of building legitimate prestige for the individual through the contributions that he makes to the progress of the organization. It is imperative in these days of rapid technologic advance that the engineer constantly keep himself abreast of the times. If for no other reason than the wealth of technical information which is available to him through the Society, membership is well worth all it costs and that is very little.

To associate oneself with the fundamental work to which this Society is dedicated, is to gain a background that is invaluable now and in the years to come. The activity of the various technical committees offers a splendid opportunity to serve one's profession, to stimulate and keep alive one's mental processes, to mix with one's fellow-men, to broaden one's viewpoint.

The AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS faces a great future. It was founded upon high ideals of service. It is an organization to which any one should be proud to belong. Its organizers and leaders for more than two decades have been responsible for the development of the scientific background which is at the root of all progress in heating and ventilating engineering. They are the leaders in their fields today. The younger and newer members of the Society will be the leaders of tomorrow, because they have accepted the duties and responsibilities of their profession by sharing in the support of this Society. My continued interest in the A.S.H.V.E. springs from a sincere conviction of its continuing benefits and I am glad of this opportunity to present its advantages as I see them.

Proceedings of the Semi-Annual Meeting 1937

American Society of Heating and Ventilating Engineers

New Ocean House, Swampscott, Mass., June 24-26

ONE of the largest Semi-Annual Meetings of the Society was held at the New Ocean House, Swampscott, Mass., during the week of June 24-26, where members and guests totalling 380 were in attendance from all parts of the United States and Canada to enjoy the entertainment program provided by the Massachusetts Chapter and the technical discussions of a group of interesting subjects.

Two Council meetings were held during the sessions at which time it was announced that favorable action had been taken upon the application for the Golden Gate Chapter charter in San Francisco, Calif., and that the Semi-Annual Meeting 1938 is to be held June 20-22 at The Homestead, Hot Springs, Va. In addition to the general Research Committee luncheon and meeting on Thursday, several technical advisory groups met to consider the instigation of new research projects. Members of the Guide Publication Committee were in full attendance at their dinner session held Wednesday evening, and the Nominating Committee convened to select Society officers and Council members for the year 1938.

FIRST SESSION—

Thursday, June 24, 9:30 A. M.

Pres. D. S. Boyden, Boston, Mass., called the Semi-Annual Meeting 1937 to order Thursday morning at the New Ocean House, Swampscott, Mass. Prof. James Holt, president of Massachusetts Chapter, welcomed the members, guests and ladies to New England and expressed appreciation for the large number in attendance.

A brief response was made by President Boyden, who then announced the first technical paper, The Adaptability of Precooling Coils to Air Washer Systems, by John Everetts, Jr., which was presented by W. L. Fleisher, New York, N. Y. (Published in July, 1937 Journal Section, *Heating, Piping and Air Conditioning*). Oral discussion was contributed by Prof. B. M. Woods, Berkeley, Calif., and C. O. Radden, Boston, Mass.

S. S. Sanford, Detroit, Mich., presented the paper, How Much Power Will an Air Conditioning System Use, by A. D. Marston. (Published in August, 1937 Journal Section, *Heating, Piping and Air Conditioning*). Written discussions were read from C. W. Walton, Jr., New York, N. Y., and J. deB. Shepard, Baltimore, Md. Other comments were given by W. J. Kyle, Chicago, Ill., A. B. Newton, Minneapolis, Minn., L. Ourusoff, Washington, D. C., E. A. Wagner, Pittsfield, Mass., and F. V. Paige, Boston, Mass.

The next paper, Cooling Load Analysis of a Bank Building, by John James, New York, N. Y., was presented by the author and verbal comments were offered by A. E. Stacey, Jr., New York, N. Y. (To be published in September, 1937 Journal Section, *Heating, Piping and Air Conditioning*).

The final paper on the technical program was Study of Summer Cooling in the Research Residence Using Water at Temperatures of 52F and 46F, by A. P. Kratz, S. Konzo and E. L. Broderick. (Published in May and June, 1937 Journal Sections, *Heating, Piping and Air Conditioning*). Presentation of the paper was made by S. Konzo, Urbana, Ill., and written discussions were contributed by T. F. Rockwell, Pittsburgh, Pa., John Everetts, Jr., New York, N. Y., E. V. Fineran, Washington, D. C., and H. M. Betts, Minneapolis, Minn. Additional comments were offered by Prof. A. P. Kratz, Urbana, Ill., and then Mr. Konzo gave a few closing remarks in answer to the questions raised in the written discussions.

L. A. Harding, Buffalo, N. Y., chairman of the Joint A.S.H.V.E.—*A.S.R.E.* Committee on National Standards for Air Conditioning Applications, read the Proposed Code of Minimum Requirements for Comfort Air Conditioning and invited discussion. Oral comments with reference to the code were presented by Mr. Fleisher and J. J. Aeberly, Chicago, Ill.

SECOND SESSION—

Friday, June 25, 9:30 A. M.

The second session was called to order by President Boyden, who announced the first paper, Calculated Over-all Coefficients for Walls with Air Space Insulation, by F. B. Rowley. (Published in July, 1937 Journal Section, *Heating, Piping and Air Conditioning*). Presentation was made by C. M. F. Peterson, Cambridge, Mass., and oral comments were presented by B. L. Cushing, Kenmore, N. Y.

President Boyden introduced Prof. G. B. Wilkes, Cambridge, Mass., who presented the paper, Radiation and Convection Across Air Spaces in Frame Construction, by G. B. Wilkes and C. M. F. Peterson. (Published in August, 1937 Journal Section, *Heating, Piping and Air Conditioning.*) Comments by Prof. F. E. Giesecke, College Station, Tex., were answered by the author.

Prof. G. L. Tuve, Cleveland, Ohio, was introduced and presented the paper, Performance of Fin-Tube Units for Air Cooling and Dehumidifying, by G. L. Tuve and

D. S. Boyden, Boston, Mass.
President

C. A. McKeeman. (Published in June, 1937 JOURNAL SECTION, *Heating, Piping and Air Conditioning*). Written discussions were read from William Goodman, La-Crosse, Wis., Harry Schmidt, Buffalo, N. Y., J. G. O'Flaherty, London, Ont., Can., R. H. Norris, Schenectady, N. Y., H. B. Pownall, York, Pa., and Mr. Newton. Oral comments were presented by C. F. Wood, Dayton, Ohio, W. H. Carrier, Newark, N. J., Mr. Harding and Mr. Fleisher. The co-author of the paper, Professor C. A. McKeeman, Cleveland, Ohio, closed the discussion with a few comments in answer to the several questions presented.

The final paper of the session, The Cooling and Heating Rates of a Room with Different Types of Steam Radiators and Convectors, by A. P. Kratz, M. K. Fahnestock and E. L. Broderick, was presented by Professor Fahnestock, Urbana, Ill. (Published in April, 1937 JOURNAL SECTION, *Heating, Piping and Air Conditioning*). Several comments were offered by S. H. Downs, Kalamazoo, Mich., and Mr. Radden.

THIRD SESSION—

Saturday, June 26, 9:30 A. M.

The final session of the Semi-Annual Meeting was opened by President Boyden. H. C. Murphy, Louisville, Ky., was introduced and read the paper, An Alternate Method of Comparing the Dust Arrestance of Air Cleaning Devices, by Arthur Nutting. (Published in August, 1937 JOURNAL SECTION, *Heating, Piping and Air Conditioning*). Written discussions were read from Prof. Philip Drinker, Boston, Mass., R. S. Dill, Washington, D. C., Otto Wechsberg, Worcester, Mass., R. F. Norris, Madison, Wis., S. R. Lewis, Chicago, Ill., and Margaret Ingels, Newark, N. J. Verbal comments were given by Mr. Fleisher, Professor Tuve, G. W. Penney, Pittsburgh, Pa., and Mr. Murphy closed the discussion, which he indicated would be answered more fully by the author in the Society's TRANSACTIONS.

President Boyden introduced Prof. C. P. Yaglou, Boston, Mass., who gave the paper, Ventilation Requirements (Part 2), by C. P. Yaglou and W. N. Witheridge. (Published in July, 1937 JOURNAL SECTION, *Heating, Piping and Air Conditioning*). Written comments were read from Dr. W. J. McConnell, New York, N. Y., Mr. Aeberly, C. M. Ashley, Newark, N. J., and Perry West, Lexington, Ky. Several verbal comments were contributed by Mr. Aeberly and Mr. Carrier, which were answered by the author in closing.

Prof. R. R. Seeber, Houghton, Mich., presented the paper, Corrosion Studies in Steam Heating Systems, by R. R. Seeber, and Margaret R. Holley. (Published in June, 1937 JOURNAL SECTION, *Heating, Piping and Air Conditioning*). Before opening the meeting to general discussion of the paper, President Boyden introduced J. H. Walker, Detroit, Mich., who outlined the history of the present research investigation and told of the financial cooperation the Society had received from several interested organizations. Written comments were read from Thomas Finnegan, New York, N. Y., C. A. Dunham, Chicago, Ill., F. L. Laque, New York, N. Y., D. D. Jacobus, Hoboken, N. J., F. N. Speller, Pittsburgh, Pa., R. M. Palmer, New York, N. Y., and E. W. Guernsey, Baltimore, Md.

The final paper of the meeting, Heating Requirements of an Office Building as Influenced by the Stack Effect, by F. C. Houghten and Carl Gutberlet, was given by F. C. Houghten, Pittsburgh, Pa. (Published in July, 1937 JOURNAL SECTION, *Heating, Piping and Air Conditioning*). A written discussion was read from Mr. Walton and W. C. Randall, Detroit, Mich., commented on the paper orally.

Amendment to Constitution and By-Laws

Secy. A. V. Hutchinson read the Amendment to the By-Laws of the Society as approved by the Council.

Article B-II, Section 5. Any person who has been a member of the Society for fifteen (15) years or more upon reaching the age of seventy (70) shall have his dues remitted for the current year and for ensuing years, without surrendering any of the privileges of membership as long as he lives.

To Be Amended as Follows: Any Member or Associate Member who has paid annual dues as a Member or Associate Member for thirty (30) years and who has reached the age of sixty-five (65), shall be eligible for Life Membership.

It was moved by F. C. McIntosh, Pittsburgh, Pa., and seconded by Albert Buenger, Dayton, Ohio, that the amendment be adopted. The motion was approved unanimously.

President Boyden then called W. T. Jones, Boston, Mass., to the rostrum and requested him to install the first vice-president, who was on a round-the-world trip at the time of the last Annual Meeting. Mr. Jones called upon Mr. Carrier to act as marshal, and E. H. Gurney,

W. T. Jones G. L. Larson L. A. Harding Homer Addams W. H. Carrier C. V. Haynes

A.S.H.V.E. Past Presidents Who Enjoyed Meeting at Swampscott

Toronto, Can., was escorted to the platform where he was installed as first vice-president of the Society.

Resolutions

The following resolutions were presented by N. D. Adams, Rochester, Minn., and unanimously adopted:

Before closing this most pleasant and instructive meeting, we, the members of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, assembled in Swampscott, Mass., for the Semi-Annual Meeting 1937, wish to thank the many who are responsible for making it an outstanding success. Therefore,

Be It Resolved, That we feel deeply grateful to the weatherman, who has given us such perfect days and moonlight nights,

That we are indebted to the Massachusetts Chapter, who, under the able leadership of their general chairman, W. T. Jones, and his Committee chairmen, have worked so faithfully and efficiently,

That we appreciate the messages brought to us by the very able speakers at our technical sessions and at our banquet, to stimulate us through the coming months,

That we thoroughly enjoyed the scenic trips brought to us through pictures taken by our president, D. S. Boyden, and L. C. Soule, who have proven themselves to be real artists in choosing the worthwhile sights along the way,

That we are appreciative of the excellent service and courtesies extended by the management of the New Ocean House.

That we thank the press for its generous support in giving space and publicity to the activities and the worthwhile papers which have been presented at our sessions,

That we express our pleasure to the Canadian members for their thoughtful courtesy in presenting their banner, which will float beside our Stars and Stripes at all future meetings and thereby further cement the neighborly feeling between us and emphasize the international character of the Society, and

Be It Further Resolved, That to all who have contributed toward making this meeting such a happy one we want to say that we are glad we have come and will long remember this outstanding meeting.

Entertainment

The Semi-Annual Meeting of the A.S.H.V.E. brought 380 members and guests from 20 of the United States and Canada to the New Ocean House at Swampscott, Mass., to enjoy the technical sessions and the program of entertainment which had been planned by the local Committee on Arrangements.

W. T. Jones, general chairman, and committee members were on deck all during the meeting to greet their guests and see that their plans were efficiently carried out. A. S. Kellogg was in charge of Registration and Reception and was assisted by C. R. Swaney, R. A. Spence and H. B. Wiegner. Prof. James Holt, president of Massachusetts Chapter, was chairman of the Entertainment and Ladies Committee with C. T. Flint, H. C. Moore and John Turner as members. Transportation arrangements were ably taken care of by T. F. McCoy, chairman, G. B. Gerrish and W. A. McPherson. J. F. Tuttle was busy as chairman of the Golf Committee and those who worked with him were R. S. Franklin and A. F. Karlson. Finances were accounted for by W. E. Barnes, chairman, Edgar Shaw and J. W. Brinton. R. M. Nee had charge of matters of Publicity and other members of the committee were E. T. Keefe and H. E. Whitten. Mrs. W. T. Jones made certain that the visiting ladies were having a good time and among those who assisted her were Mrs. D. S. Boyden, Mrs. James Holt, Mrs. J. F. Tuttle and Mrs. A. S. Kellogg.

Registration began on Wednesday, June 23, at 1:00 p. m. and during the evening Pres. and Mrs. D. S. Boyden received members and guests in the Priscilla Room. Dancing was enjoyed by some, while others were attracted outdoors by the moonlight on the water. Movies which were taken by Colonel Boyden a year ago at Buck Hill Falls, Pa., were shown and were of particular interest to those who had attended the party on Skytop Mountain.

Technical sessions were held in the mornings and the afternoons and evenings were free for committee meetings and pleasure. One of the most popular features was the boat trip to Gloucester on Thursday at 1:30 p. m., when 135 were taken in buses from the hotel to Marblehead where they boarded the boat. Golfers left at 2:00 p. m. for the Tedesco Country Club where an 18-hole Kicker's Handicap was played. An informal party was held in the evening with a concert and dancing. An added pleasure was the films shown by L. C. Soule which he had taken on a recent trip to Hawaii.

On Friday morning a large group left by bus at 9:30 for Boston where they visited Harvard Museum and the glass flower exhibit, as well as some of the nearby historic points of interest.

The 18-hole medal play tournament for the Research and Chapter cups was played Friday afternoon at the Tedesco Country Club and the enthusiastic golfers left promptly after luncheon.

The ladies were entertained at a bridge party in the library and there were eight tables playing from 2:30 to 4:30 p. m. when tea was served. Those who received prizes for their skill were Mrs. C. E. Price, Winnetka, Ill., Mrs. W. M. Brown, Haddonfield, N. J., Mrs. T. F. Rockwell, Pittsburgh, Pa., Mrs. F. E. Giesecke, College Station, Tex., Mrs. N. D. Adams, Rochester, Minn., Mrs. R. R. Seeber, Houghton, Mich., Mrs. Edward Atchison, Slatersville, R. I., and Mrs. C. M. Brigham, Chicago, Ill.

This year the annual banquet on June 26 was featured by a New England Shore Dinner, and music and vocal selections added to the general enjoyment. W. T. Jones was toastmaster and introduced W. H. Carrier, Newark, N. J., who made the presentation of the Past President's Memory Book to Prof. G. L. Larson, Madison, Wis.

A stirring event was the presentation of a Canadian flag given by Montreal Chapter in honor of the Society's Canadian first vice-president, E. H. Gurney, and to extend the feeling of neighborliness and emphasize the international character of the Society. Marching through the banquet room to the speakers' table, the color guard was accompanied by C. Tasker, who presented the new Canadian flag which was accepted for the A.S.H.V.E. by President Boyden. In making the presentation, Mr. Tasker said:

"The Canadian membership in the Society is approaching 200, and the Montreal Chapter, which received its charter a lit-

tle over a year ago, is rapidly approaching its first hundred members.

"The president of the Montreal Chapter, G. Lorne Wiggs, had expected to be present with us this evening to perform this duty, but he being unavoidably detained in Montreal, I have been asked by the Montreal Chapter representatives to act on their behalf and present to you, Sir, as president of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, this Canadian flag with the request that it shall be used alongside its sister flag at the Annual and Semi-Annual Meetings of the Society, to remind us of the international character of the Society, and to further cement the already very strong bonds of friendship and fellowship existing between the members of the Society on both sides of the border."

The singing of God Save the King and the Star Spangled Banner concluded this ceremony.

Mr. Jones called on the various committee chairmen to rise and Mr. Tuttle announced the winners of the golf tournaments. The Research Cup was presented to R. C. Bolsinger, Conshohocken, Pa., and the Eichberg Memorial Cup went to Illinois Chapter, J. C. Matchett receiving it for the chapter team.

GOLF PRIZE WINNERS—SEMI-ANNUAL MEETING, A.S.H.V.E.
Kicker's Handicap

NAME	PLACE	PRIZE
C. E. Mayette	Washington, D. C.	Cocktail Set
N. D. Adams	Rochester, Minn.	Cocktail Set
J. C. Matchett	Chicago, Ill.	Silex
Tom Brown	Chicago, Ill.	Silex
E. B. Badger	Boston, Mass.	Bathroom Scale
H. C. Bates	Corning, N. Y.	Electric Heating Pad
W. J. Osborn	Fairfield, Conn.	Vacuum Jug
John Turner	Boston, Mass.	Electric Clock
H. H. Erickson	Philadelphia, Pa.	Electric Clock
T. J. Swan	Boston, Mass.	Pipe
F. A. Merrill	Boston, Mass.	Pipe

Medal Play

Research Cup—R. C. Bolsinger, Philadelphia
Research Cup—A. E. Knapp, Detroit, runner-up—Platter
Eichberg Memorial Cup—Illinois Chapter Team

Jack Brigham	Chicago, Ill.	Platter
L. J. Pitcher	Chicago, Ill.	Vegetable Dish
M. F. Blankin	Philadelphia, Pa.	Electric Clock
R. V. Sawhill	New York, N. Y.	Vegetable Dish
W. L. Fleisher, Jr.	New York, N. Y.	Traveling Case
D. S. Boyden	Boston, Mass.	Electric Clock
C. E. Price	Chicago, Ill.	Pipe
Special Prize		
W. H. Oleson	Boston, Mass.	Vacuum Cleaner

18 Hole Medal Play Tournament
Research Cup and Chapter Cup

NAME	GROSS	HANDICAP	NET
E. T. Keefe	90	16	74
H. W. Coombs	...	30	NC
J. A. Boyle	111	30	81
C. F. Roche	109	30	79
J. F. Hyde	97	20	77
K. F. Bowkett	110	30	80
R. C. Bonthron	112	16	96
W. J. Osborn	92	14	78
W. H. Carrier	102	23	79
C. V. Haynes	100	22	78
D. S. Boyden	93	21	72
R. C. Bolsinger	79	11	68
A. F. Kriebel	120	30	90
R. S. Arnold	116	30	86
J. McElgin	110	30	80
H. H. Erickson	108	30	78
H. B. Hedges	103	24	79
W. F. Smith	107	16	91
L. P. Haynes	143	30	113
C. M. Brigham	100	20	80
Jack Brigham	81	10	71
Tom Byrd	116	25	91
W. R. Fraser	93	18	75
H. D. Jackes	88	14	74
G. W. Barr	108	20	88
E. B. Freeman	97	18	79
A. C. Bartlett	103	23	80
C. G. Binder	144	40	104
R. V. Sawhill	101	30	71
J. F. Tuttle	98	18	80
R. S. Franklin	98	16	82
R. T. Miller	100	23	77
J. Boyrer	84	7	77
H. C. Bates	109	25	84
E. A. Wagner	112	28	84
C. A. McKeeman	116	25	91
J. C. Matchett	99	27	72
C. E. Mayette	107	28	79
B. H. Schulze	119	30	79
I. H. Geiger	97	18	79
J. R. Murphy	102	18	84
L. N. Hunter	113	23	90
M. F. Blankin	89	12	77
G. E. Olsen	109	25	84
G. B. Gerrish	109	28	81
L. J. Pitcher	88	12	76
Tom Brown	94	15	79
F. W. Hicks	114	25	89
A. E. Knapp	89	20	69
T. F. McCoy	...	30	NC
G. P. Dickson	...	25	NC
R. W. Graham	...	30	NC
M. K. Fahnestock	107	30	77
P. D. Close	...	30	NC
E. J. Rodee	...	30	NC
W. L. Fleisher	97	24	73
W. L. Fleisher, Jr.	102	30	72
C. E. Price	92	19	73
W. H. Oleson	105	13	92

18 Hole Kicker's Handicap Tournament

NAME	GROSS	HANDICAP	NET
E. T. Keefe	96	12	84
W. T. Hall	...	15	NC
E. B. Badger	94	16	78
H. W. Coombs	...	24	NC
R. W. Graham	...	35	NC
R. C. Bonthron	...	15	NC
E. B. Freeman	102	16	86
I. H. Geiger	97	18	79
C. E. Mayette	101	25	76
J. C. Matchett	101	24	77
I. C. Jennings	117	25	92
J. F. G. Miller	109	18	91
A. C. Bartlett	104	18	86
R. S. Franklin	103	20	83
C. E. Price	106	22	84
N. D. Adams	105	30	75
N. D. Adams, Jr.	125	25	100
E. MacNaughton	105	35	70
A. S. Widdowfield	...	35	NC
L. N. Hunter	125	23	102
J. R. Murphy	110	22	88
C. G. Binder	136	40	96
R. V. Sawhill	111	28	83
C. V. Haynes	112	25	87
W. H. Carrier	107	25	82
D. S. Boyden	102	21	81
M. F. Blankin	90	12	78
A. E. Knapp	96	15	81
F. W. Hicks	110	25	85
R. E. Keyes	...	30	NC
W. E. Heibel	...	30	NC
C. L. Renker	126	35	91
C. R. Wilson	133	35	98
J. F. McIntire	...	25	NC
E. H. Gurney	...	25	NC
E. R. Gurney	...	30	NC
C. M. Brigham	103	17	86
J. B. Brigham	86	10	76
L. J. Pitcher	95	12	83
Tom Brown	90	13	77

R. E. Moore	100	16	84
A. L. Simison	132	29	103
F. B. Mahon	95	25	70
E. A. Wagner	120	28	92
H. C. Bates	103	25	78
W. C. Randall	...	32	NC
W. J. Osborn	93	20	73
R. C. Bolsinger	91	12	79
W. R. Fraser	98	18	80
T. J. Swan	97	18	79
E. F. Dunn	80	9	71
F. A. Merrill	99	20	79
J. Turner	97	24	73
W. E. Kingswell	104	23	81
A. Richards	136	35	101
R. T. Miller	105	20	85
A. E. Kriebel	121	35	86
J. McElgin	116	20	86
H. B. Hedges	112	18	94
H. H. Erickson	109	30	79
B. L. Cushing	124	30	94
J. F. Tuttle	95	18	77
A. G. Sutcliffe	133	35	98
J. F. Hyde	102	20	82
R. M. Nee	104	40	64
J. H. Barrett	116	31	85
H. D. Jackes	...	13	NC

Recognition was given to Mrs. Lilian Vaughan, Salem, Oregon, as the lady who came the longest distance to Swampscott.

During the evening Mr. Jones expressed the pleasure of the members at the presence of their distinguished guests, Dr. Karl T. Compton, president of Massachusetts Institute of Technology, and Dean Harry P. Burden, Engineering School, Tufts College, who responded briefly.

President Boyden spoke and introduced the presidents of Chapters who were at the meeting. He presented the speaker of the evening, the Hon. Frederick W. Cook, secretary of the Commonwealth of Massachusetts. In a delightful manner, Mr. Cook expressed his pleasure at attending the banquet and his informal talk was greatly enjoyed by the members and guests.

The speeches were notable for their wit and brevity so that ample time was available to enjoy the dancing which followed.

On Saturday morning a trip had been planned to visit a number of the North Shore Gardens, but this was necessarily canceled because of showers. However, with this one exception the Committee felt that they were particularly fortunate in having ideal weather.

During June 23-26, the Council held two meetings on Wednesday afternoon and Thursday evening. The Guide Publication Committee had dinner and a meeting June 23, and the Nominating Committee held a breakfast meeting Thursday morning. A luncheon and business session of the Committee on Research took place on Thursday and meetings were held by the Committee on Insulation, Committee on Cooling Load Factors, Committee on Comfort Air Conditioning, and Committee on Air Cleaning.

Those members and guests who visited the New Ocean House, Swampscott, Mass., for the first time were thrilled by the beauties and opportunities for enjoyment, while others who had attended the Semi-Annual Meeting in 1931 renewed pleasant associations. The local committee extended a friendly welcome to New England and the 1937 Semi-Annual Meeting will long be remembered by A.S.H.V.E. members and guests, 380 being present.

Air Conditioning School

A new air conditioning and refrigeration training school, the Thermo Air Conditioning Institute, Inc., 186 S. Alvarado St., Los Angeles, Calif., opened its doors recently and first classes are now being held. The school is headed by F. G. Baender, member A. S. H. V. E., and includes on its advisory board a number of well-known individuals in the industry.

Mr. Baender has long been associated with the educational and professional phases of engineering practice. He has headed the departments of mechanical engineering at Oregon State College and the University of Arkansas, and served variously as consulting, research, and designing engineer with well-known equipment manufacturers.

The several courses of the Institute combine intensive study of the theory and principles of air conditioning and refrigeration and practical training in the shops. Equipment used for student instruction includes practically every type of apparatus found in modern commercial and domestic systems with a portion of it being used to air condition the entire building.

Dust Control Equipment Association Meets

At a meeting of the *Dust Control Equipment Association* in Cleveland during June attention was given to reports from the Engineering Committee of the association dealing with work in establishing standards of dust control practice.

The several courses of the Institute combine intensive study gard to the adoption of a friction chart and the development of a formula for use in connection with the chart were endorsed by the association.

An address by Theodore Hatch, associate dust control engineer, Division of Industrial Hygiene, Department of Labor, State of New York, was given on the subject, Importance of Modern Standards and Methods of Dust Analysis upon Design and Efficiency of Dust Control Equipment. Mr. Hatch spoke in the light of his personal knowledge and opinions and discussed methods used in cleaning dust from air in South African gold mines. He spoke in detail on the question of the size of dust particles and the relative importance of the different kinds of dust, and also discussed various types of equipment available for determining dust count and showed why he considered it unsatisfactory to establish factors on the basis of a very close determination.

Bureau of Mines Continues Survey of American Coals

Several additional coals have been added to the list whose properties and special characteristics are being investigated by the U. S. Bureau of Mines, Department of the Interior, in cooperation with the *American Gas Association*. The most recent coals reported are from the Clintwood Bed, Buchanan County, Virginia, Millers Creek Bed, Johnson County, Kentucky, and Pittsburgh Bed, Washington County, Pennsylvania, in papers prepared by A. C. Fieldner, J. D. Davis and others.

Since the manufactured gas industry uses as its major raw material bituminous coal, it, therefore, desires fuller knowledge of this material. The present survey is gradually collecting information to make a complete picture of the characteristics of the various coals available in America and much of the original work was described in a previous publication, Monograph No. 5, entitled, Gas-, Coke- and Byproduct-Making Properties of American Coals and Their Determination.

Microscopically, Clintwood coal is irregular in composition containing splint and bright coals in varying proportions. This coal is described in Technical Paper 570.

The coal from Pittsburgh Terminal No. 9 Mine of Washington County, Pennsylvania, described in Technical Paper 571, is interesting because the sulphur content is higher than that of any coal of the series previously tested.

The results of the study of Miller's Creek Bed Coal from Consolidation No. 155 Mine, Johnson County, Kentucky, are described in Technical Paper 572. Its coking properties were found to be considerably improved by blending with small proportions of other coals.

The publications describing tests on these coals may be secured from the Superintendent of Documents, Government Printing Office, Washington, D. C., at a cost of 10c each.

NEWS OF LOCAL CHAPTERS

OFFICERS OF LOCAL CHAPTERS—1937

ATLANTA: *Organized,* 1937. *Headquarters,* Atlanta, Ga. *President,* E. W. KLEIN, 152 Nassau St., N. W. *Secretary,* C. T. BAKER, 713 Glenn St., S. W.

CINCINNATI: *Organized,* 1932. *Headquarters,* Cincinnati, O. *Meets,* Second Tuesday in Month. *President,* I. B. HELBURN, 610 Chamber of Commerce Bldg. *Secretary,* H. E. SPROULL, 1005 American Bldg.

GOLDEN GATE: *Organized,* 1937. *Headquarters,* San Francisco, Calif. *President,* B. M. WOODS, Univ. of Calif., Berkeley, Calif. *Secretary,* G. J. CUMMINGS, 113 Tenth St., Oakland, Calif.

ILLINOIS: *Organized* 1906. *Headquarters,* Chicago, Ill. *Meets,* Second Monday. *President,* L. S. RIES, 960 East 58th St. *Secretary,* C. E. PRICE, 6 N. Michigan Ave.

KANSAS CITY: *Organized,* 1917. *Headquarters,* Kansas City, Mo. *Meets,* Second Monday in Month. *President,* A. H. SLUSS, 827 Mississippi Ave., Lawrence, Kan. *Secretary,* GUSTAV NOTTBERG, 914 Campbell St.

MANITOBA: *Organized,* 1935. *Headquarters,* Winnipeg, Man. *Meets,* Fourth Thursday. *President,* D. F. MICHIE, 5B, 553 Wardlaw Ave.

MASSACHUSETTS: *Organized,* 1912. *Headquarters,* Boston, Mass. *Meets,* Second Tuesday in Month. *President,* JAMES HOLT, Massachusetts Institute of Technology, Cambridge, Mass. *Secretary,* JOHN TURNER, 285 Columbus Ave.

MICHIGAN: *Organized,* 1916. *Headquarters,* Detroit, Mich. *Meets,* First Monday after the 10th of the Month. *President,* F. J. FEELY, 950 Trombley Rd., Grosse Pointe Pk. *Secretary,* G. H. TUTTLE, 2000 Second Ave.

WESTERN MICHIGAN: *Organized,* 1931. *Headquarters,* Grand Rapids, Mich. *Meets,* Second Monday in Month. *President,* W. W. BRADFIELD, 901 Michigan Trust Bldg. *Secretary,* S. W. TODD, JR., 309 Paris, S. E.

MINNESOTA: *Organized,* 1918. *Headquarters,* Minneapolis, Minn. *Meets,* Second Monday in Month. *President,* R. E. BACKSTROM, Room 1981, First Natl. Bank Bldg., St. Paul, Minn. *Secretary,* F. C. WINTERER, 836 Juno St., St. Paul, Minn.

MONTREAL: *Organized,* 1936. *Headquarters,* Montreal, Que. *Meets,* Third Monday. *President,* G. L. WIGGS, University Tower. *Secretary,* C. W. JOHNSON, 630 Dorchester St., W.

NEW YORK: *Organized,* 1911. *Headquarters,* New York, N. Y. *Meets,* Third Monday in Month. *President,* W. E. HEIBEL, 11 West 42nd St. *Secretary,* T. W. REYNOLDS, 100 Pinecrest Dr., Hastings-on-Hudson, N. Y.

WESTERN NEW YORK: *Organized,* 1919. *Headquarters,* Buffalo, N. Y. *Meets,* Second Monday in Month. *President,* B. C. CANDEE, 19 Tremont Ave., Kenmore, N. Y. *Secretary,* W. R. HEATH, 119 Wingate Ave.

NORTHERN OHIO: *Organized,* 1916. *Headquarters,* Cleveland, O. *Meets,* Second Thursday in Month. *President,* PHILIP COHEN, 401 East Ohio Gas Bldg. *Secretary,* C. A. MCKEEMAN, Case School of Applied Science.

OKLAHOMA: *Organized,* 1935. *Headquarters,* Oklahoma City, Okla. *Meets,* Second Monday. *President,* F. X. LOEFFLER, 1604 N. W. Fifth St. *Secretary,* E. W. GRAY, Box 1498.

ONTARIO: *Organized,* 1922. *Headquarters,* Toronto, Ont. *Meets,* First Monday in Month. *President,* G. A. PLAYFAIR, 97 Jarvis St. *Secretary,* H. R. ROTH, 57 Bloor St. W.

PACIFIC NORTHWEST: *Organized,* 1928. *Headquarters,* Seattle, Wash. *Meets,* Second Tuesday in Month. *President,* S. D. PETERSON, 473 Colman Bldg. *Secretary,* D. C. GRIFFIN, Orpheum Bldg.

PHILADELPHIA: *Organized,* 1916. *Headquarters,* Philadelphia, Pa. *Meets,* Second Thursday in Month. *President,* L. P. HYNES, 240 Cherry St. *Secretary,* C. B. EASTMAN, 530 Brookview Lane, Brookline, Upper Darby, Pa.

PITTSBURGH: *Organized,* 1919. *Headquarters,* Pittsburgh, Pa. *Meets,* Second Monday in Month. *President,* M. L. CARR, P. O. Box 1646. *Secretary,* T. F. ROCKWELL, Carnegie Inst. Tech.

ST. LOUIS: *Organized,* 1918. *Headquarters,* St. Louis, Mo. *Meets,* First Tuesday in Month. *President,* G. W. F. MYERS, 3947 W. Pine Blvd. *Secretary,* D. J. FAGIN, 1344 Woodruff Ave.

SOUTHERN CALIFORNIA: *Organized,* 1930. *Headquarters,* Los Angeles, Calif. *Meets,* Second Tuesday in Month. *President,* E. H. KENDALL, 1978 S. Los Angeles St. *Secretary,* J. F. PARK, 1234 South Grand.

TEXAS: *Organized,* 1936. *Headquarters,* College Station, Texas. *President,* R. F. TAYLOR, Santa Fe Bldg., Dallas, Tex. *Secretary,* W. H. BADGETT, Texas A. & M. College.

WASHINGTON, D. C.: *Organized,* 1935. *Headquarters,* Washington, D. C. *Meets,* Second Wednesday in Month. *President,* L. OURUSOFF, 411 Tenth St., N. W. *Secretary,* L. F. NORDINE, Room 210, 726 Jackson Pl., N. W.

WISCONSIN: *Organized,* 1922. *Headquarters,* Milwaukee, Wis. *Meets,* Third Monday in Month. *President,* J. H. VOLK, 1906 W. St. Paul Ave. *Secretary,* H. C. FRENTZEL, 3000 W. Montana St.

Minnesota Chapter Entertains Pres. Boyden and Winnipeg Members

May 7 and 24, 1937. Minnesota Chapter had an active month during May when on the 7th they were host to Col. D. S. Boyden, Boston, Mass., president of the A.S.H.V.E. In his address to the Chapter, President Boyden gave a resumé of activities of the A.S.H.V.E. since its inception, and also presented an interesting and detailed description of problems involved in operating a district heating system.

On May 24, members of the Winnipeg Chapter and their wives were guests of Minnesota Chapter at a joint meeting held at Minneapolis. Following a trip through the University of Minnesota in the morning, the men played golf at the Golden Valley Country Club. In the evening, dinner was served in the club dining room and then followed a brief meeting at which the following new officers were installed:

President—R. E. Backstrom.
Vice-President—J. E. Swenson.
Secretary-Treasurer—F. C. Winterer.

The ladies too had an enjoyable program for the day, visiting the shopping center and having dinner at the Minneapolis Automobile Club at Bloomington.

From all reports the activities of the month seemed to be very successful, according to Mr. Swenson.

Southern California Chapter Meets With Local A.S.R.E. Group

May 11, 1937. The Southern California Chapter of the A.S.H.V.E. held a joint meeting with the local section of the *A.S.R.E.* at the Broadway Club. H. M. Hendrickson reports that the attendance of 211 members and guests gave evidence of the enthusiasm with which these joint meetings are received. Engineering students from several air conditioning schools were especially invited to be present to hear Dr. B. M. Woods speak on Air Conditioning and about 40 responded. At 6:15 p. m. dinner was served, preceding the business session.

Pres. Leo Hungerford presided at the meeting and welcomed the *A.S.R.E.* members, and the students and guests. The floor was then given to Chairman J. C. Blair of *A.S.R.E.*, who expressed the pleasure of his organization at being present and announced the newly elected officers of the local *A.S.R.E.* Section.

President Hungerford then reported the results of the balloting for A.S.H.V.E. Chapter officers for the coming year, the following candidates being unanimously elected:

President—E. H. Kendall
Vice-President—H. M. Hendrickson
Secretary—J. F. Park
Treasurer—A. W. Cooper
Board of Governors—O. W. Ott, P. C. Scofield, W. D. Fabling, Leo Hungerford.

O. W. Ott was called upon to present R. L. Gifford with his life membership certificate in the A.S.H.V.E., and Mr. Ott made a very appropriate presentation speech, to which Mr. Gifford responded.

Mr. Ott then reported for the Research Committee and announced that cooperative research work was about to begin on the cooling tower and surface cooling research project at the University of California, Berkeley. He also told of the organization of a new Chapter in San Francisco, of which the speaker of the evening, Dr. Woods, is the first president.

In introducing Dr. Woods, Pres. Kendall told of his specialized research work in engineering and expressed the pleasure of the membership on having him address the meeting.

Dr. Woods, dean of engineering, University of California, Berkeley, Calif., chose for his subject, The Progress in Air Conditioning Studies, in which he told of research work being done at the university. Four fields for further research in air conditioning were pointed out as follows: dust in the air; automatic regulation; performance of cooling towers; and heat pumps. Dr. Woods spoke at length on comfort conditions for both winter and summer, and the effect of radiation on the feeling of comfort. His talk was illustrated by slides and proved intensely interesting to the audience.

After adjournment at 9:30 p. m., the evening continued with a half-hour of singing, dancing and accordion music.

Electrical Engineers Elect Officers

At the annual meeting of the *American Institute of Electrical Engineers* held in Milwaukee, Wis., the election of the following officers was announced for the year beginning August 1, 1937: *President*—W. H. Harrison, New York, N. Y.; *Vice-presidents*—I. M. Stein, Philadelphia, Pa., E. D. Wood, Louisville, Ky., L. N. McClellan, Denver, Colo., J. P. Jollyman, San Francisco, Calif., M. J. McHenry, Toronto, Ont.; *Directors*—C. R. Beardsley, Brooklyn, N. Y., V. Bush, Cambridge, Mass., F. H. Lane, Chicago, Ill.; *Treasurer*—W. I. Slichter, New York, N. Y.

These officers together with the following hold-over officers will constitute the Board of Directors for the next administrative year: A. M. MacCutcheon, Cleveland, O., O. B. Blackwell, New York, N. Y., L. T. Blaisdell, Dallas, Tex., F. M. Farmer, New York, N. Y., N. E. Funk, Philadelphia, Pa., H. B. Gear, Chicago, Ill., C. F. Harding, Lafayette, Ind., F. E. Johnson, Columbia, Mo., C. R. Jones, New York, N. Y., W. B. Kouwenhoven, Baltimore, Md., K. B. McEachron, Pittsfield, Mass., C. A. Powel, East Pittsburgh, Pa., C. E. Rogers, Seattle, Wash., R. W. Sorensen, Pasadena, Calif., A. C. Stevens, Schenectady, N. Y., and J. B. Whitehead, Baltimore, Md.

New York World's Fair

Architects, engineers, mural painters, industrial designers, sculptors, lighting experts and landscape architects attended a luncheon meeting on July 8 in the Administration Building of the New York World's Fair 1939. Following the meeting a tour of the Fair grounds was made.

Grover Whalen, president of the Fair Corporation, presided and S. F. Voorhees, chairman of the Fair's Board of Design, gave a resumé of progress in various phases of activity, illustrating his talk with an exhibition of pictures, models and plans. Included in the display were illustrations of several new designs for two buildings to house the food and production exhibit, a model of the central exhibit section carved out of wood, and a plan of the main esplanade.

Those present included in addition to the Fair's designers, members of the Committee on Architecture and Physical Planning of which P. S. Straus is chairman. Other members are:—F. T. Davison C. E. Dodge, C. F. Kelley, George McAneny and W. C. Osborn.

The list of designers who are cooperating was made public as follows:—*Board of Design*—S. F. Voorhees, G. D. Clarke, W. A. Delano, Jay Downer, R. D. Kohn, R. H. Shreve, W. D. Teague; *Collaborators*—C. H. Aldrich, George Licht, W. F. Lamb, Charles Butler, C. S. Stein, R. T. Walker, A. L. Harmon, C. C. Colby; *Consultants*—F. W. Darling, P. P. Cret, Bassett Jones, J. E. Garnsey, Lee Lawrie, Ernest Peixotto, Allmon Fordyce, Alfred Geiffert, Jr., Hugh Ferriss; *Architects*—Harvey Stevenson, Eastman Studds, G. A. Holmes, J. A. Thompson, E. I. Williams, R. A. Kimball, E. S. Husted, D. J. Baum, Francis Keally, Leonard Dean, F. L. S. Mayers, O. H. Murray, Hardie Phillip, Eric Gugler, J. B. Slee, R. H. Bryson, Andre Fouilhoux, W. K. Harrison, F. C. Hirson, Peter Copeland, William Gehron, B. W. Morris, R. B. O'Connor, T. H. Ellett, F. G. Frost, Sr., F. G. Frost, Jr., W. W. Fenner, G. L. Paine, Pleasants Pennington, I. Woodner-Silverman, P. L. Goodwin, Eric Keboon, E. D. Stone, Morris Ketchum, Jr., R. B. Snow, Leonard Schultze, A. M. Brown, H. T. Aspinwall, P. F. Simpson, M. W. Del Gaudio, J. G. Rogers, J. H. Freedlander, M. B. Bohm, Charles Beeston, R. W. McLaughlin, Jr., A. C. Holden, Stamo Papadaki, J. C. B. Moore, Jean Labatut, S. B. Baylinson, Leon Levy, Lionel Levy, E. F. Murgatroyd, P. H. Ogden, Frederick Pavlicek, Jr., R. H. Newstead, F. P. Platt, C. L. Platt, A. S. Walker, L. N. Gillette, L. A. Reinhard, Henry Hofmeister, John Hironimus; *Mural Painters*—Dunbar Beck, John Sitton, F. S. Bradford, Miss H. Meiere, J. S. Williams, Eugene Savage, J. O. Mahoney, Andre Durenceau, Pierre Bourdelle, Carlo Ciampagia; *Sculptors*—Paul Manship, J. E. Fraser, Leo Friedlander, Albert Stewart, J. E. Renier, Joseph Kiselewski, G. H. Snowden, C. L. Schmitz, Caetano Cecere, Edmond Amateis; *Designers*—Raymond Loewy, Henry Dreyfuss, Albert Johnson; *Landscape Architects*—A. F. Brinckerhoff, C. D. Lay, H. W. Corbett, W. H. MacMurray, R. W. Cutler; and, *Consultants*—Carlton Proctor, Arthur Freeman, H. M. Brinckerhoff, A. K. Morgan, S. Hamel, R. C. Engelken, J. C. Evans, Robert Ridgway, Louis Skidmore, Daniel Ryan, N. A. Richards, Lazurus White, Otto Teegan, Henry Meyer, W. H. Sawyer, J. D. Whittemore.

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 32 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn the Coun-

cil, urge the members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is i n any way questioned.

All correspondence in regard to such matters is strictly confi dential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by August 16, 1937, these candidates will be ballotted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
AKERMAN, J. R., Engr., Phoenix Oil Co., Augusta, Ga.	L. F. Kent E. W. Klein	L. L. Kuempel D. B. Poling
ANGUS, F. M., Br. Mgr., General Refrigeration Sales Co., Cleveland, Ohio.	R. A. Wilson A. L. Vanderhoof	Philip Cohen C. A. McKeeman
ARDEN, I. L., Engr. & Mgr., Gastonia Mills Supply Co., Charlotte, N. C.	B. R. Small C. F. Templin	F. W. Clare I. B. Kagey
ATHERTON, A. E., Director, A. E. Atherton & Sons, Pty., Ltd., Melbourne, Victoria, Australia.	R. A. Hudson A. J. Bouey	G. J. Cummings W. E. Leland
BARRON, J. T., Asst. Engr., Hynes Elec. Htg. Co., Philadelphia, Pa.	L. P. Hynes J. H. Billings	Edwin Elliot J. P. Harbeson, Jr. *(A. S. M. E.)*
DOWNES, A. H., Draftsman, Pernot & Rich, Los Angeles, Calif.	A. J. Hess L. J. Rich *(Non-Member)*	J. N. Fasies *(Non-Member)* P. W. Betts *(Non-Member)*
DRAKE, G. F., Development Engr., Barber-Colman Co., Rockford, Ill.	D. J. Stewart R. P. Dewey	C. J. Braatz Bradlee Pruden
DUNNE, R. V., Engr., Carrier Corp., Newark, N. J.	W. H. Carrier R. E. Cherne	W. H. Driscoll W. A. Grant
EVANS, B. L., Design Engr., Langenberg Htg. Co., St. Louis, Mo. *(Advancement)*	E. B. Langenberg L. W. Moon	A. P. Kratz S. Konzo
GULER, G. D., Sales Engr., Minneapolis-Honeywell Reg. Co., Philadelphia, Pa.	L. P. Hynes H. B. Hedges	C. G. Binder L. A. Tucker
HALL, GEORGE, Gen. Mgr., Hyland, Hall & Co., Madison, Wis.	G. L. Larson D. W. Nelson	C. H. Randolph Ernest Szekely
HALL, JOHN R., Chief Engr., U. S. Air Conditioning Corp., Minneapolis, Minn. *(Advancement)*	L. P. Hanson A. E. Bauer	B. P. Edelman C. F. Hawkinson
HUMMEL, G. W., Field Engr. & Sales, Trane Co., La Crosse, Wis.	R. H. Anderegg R. N. Trane	M. W. Miller W. A. Rowe
HUYBERT, L. E., Jr., Sales Engr., R. F. Trant, Inc., Norfolk, Va.	Albert Buenger A. R. MacMillan	W. H. Webster, Jr. R. H. Latem *(Non-Member)*
KIPP, THEODORE, Pres. & Man. Director, Kipp-Kelly, Ltd., Winnipeg, Man., Can.	C. H. Turland J. B. Steele	E. F. Munn William Glass
LINEBAUGH, J. E., Chief Engr., Frigidaire, London, England.	E. B. Newill *(Non-Member)* David Fiske *(A. S. R. E.)*	H. M. Williams *(Non-Member)* G. A. Buvinger *(A. S. M. E.)*
MALLY, C. F., Mgr., Mally & Co., Ferndale, Mich.	F. R. Bishop E. A. Jones	Jay Barton E. B. Root
MCNEVIN, J. E., Mgr. & Vice Pres., Geo. P. Braid, Inc., Denver, Colo.	L. R. O'Rear A. F. Davis	R. E. Moore W. A. Russell
MELONEY, E. J., Vice Pres. & Secy., Bowers Bros. Co., Philadelphia, Pa.	W. P. Culbert F. D. Mensing	A. H. Woolston L. E. Moody
MOHN, H. L., Research Engr., Fitzgibbons Boiler Co., Inc., Oswego, N. Y.	G. L. Larson Homer Addams	Kenneth Mytinger G. E. Olsen
MUNRO, G. A., Gen. Mgr., H. F. Munro & Sons, Philadelphia, Pa.	J. C. Murdoch, Jr. J. H. Hucker	A. I. Rank H. G. Black
OAKLEY, L. W., Htg. Engr., Plbg. & Htg. Sales Co., Knoxville, Tenn.	J. C. Matchett A. E. Bastedo	A. G. Dixon Charles Ellis *(Non-Member)*
PHILIP, WILLIAM, Sales Engr., Dominion Radiator & Boiler Co., Toronto, Ont., Can. *(Reinstatement)*	H. B. Jenney T. H. Worthington	W. R. Blackhall D. J. MacDonald
ROSE, J. C., Air Cond. Engr., Buensod-Stacey, New York, N. Y.	A. C. Buensod H. L. Janet	S. E. Lyman A. E. Stacey, Jr.
SCHAFER, H. C., Htg. Dept., Iroquois Gas Corp., Buffalo, N. Y. *(Reinstatement)*	M. C. Beman B. C. Candee	W. E. Voisinet M. S. Jackson
SCHWARTZ, MAURICE, Sales Supervisor, Queens Borough Gas & Elec. Co., Far Rockaway, N. Y.	H. P. Morehouse R. E. Campbell	J. J. Deely F. W. Phillips
SIDELL, P. A., Student, University of Illinois, Urbana, Ill.	W. H. Severns P. E. Mohn *(A. S. M. E.)*	O. A. Leutwiler *(A. S. M. E.)* J. A. Goff *(A. S. M. E.)*
SIMONSON, G. M., Cons. Mech. Engr., San Francisco, Calif.	J. I. Krueger L. H. Cochran	A. J. Bouey G. J. Cummings
SOMMERS, W. J., Sales Repr., Sarco Co., Buffalo, N. Y.	M. F. May Joseph Davis	R. C. Taggart T. F. Murray
SPENCE, R. A., Steam Htg. Engr., Boston Edison Co., Boston, Mass.	R. M. Nee James Holt	W. T. Jones G. C. Eaton *(A. S. M. E.)*
VISSAC, G. A., Consulting Engr., Calgary, Alta., Can.	J. B. Steele D. F. Michie	William Worton Frank Thompson
WILLNER, IRA, Pres., Willner Htg. Co., Inc., New York, N. Y.	G. E. Olsen C. A. Miller	W. M. Heebner W. W. Timmis

Candidates Elected

In past issues of the JOURNAL of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. B-III, Sec. 8, of the By-Laws, the following list of candidates elected:

MEMBERS

BENTLEY, C. E., Consulting Engr., G. M. Simonson, Berkeley, Calif.

BOXALL, FREDERICK, Engr., Delco-Frigidaire Cond. Div., Dayton, Ohio.

BOYD, T. D., Sales Engr., Johnson Service Co., Cincinnati, Ohio.

CHERRY, V. H., Instructor, University of California, Berkeley, Calif.

DASING, EMIL, Vtg. Engr., Sears Roebuck & Co., Chicago, Ill.

FENKER, C. M., Design Mech. Engr., Edward J. Schulte, Archt., Cincinnati, Ohio.

FINNEY, BRANDON, Inspector, Htg. & Vtg. Div., City of Los Angeles, Calif.

FRANK, MRS. O. E., Pres., Frank Engrg. Co., New York, N. Y. *(Reinstatement)*

FREDERICK, H. W., Asst. Supt., Engrg. Div., Lehman Hall, Harvard, Cambridge, Mass.

GHILARDI, FERNAND, Chief Engr., Minneapolis-Honeywell Reg. Co., Paris, France.

HANSLER, J. E., Zone Service Mgr., Delco-Frigidaire Cond. Div., Dayton, Ohio.

HARRISON, G. G., Chief Engr., S. T. Johnson Co., Oakland, Calif.

HONERKAMP, FRITZ, Chief Engr., Anemostat Corp. of America, New York, N. Y.

HYDE, E. F., Consulting Engr., Birmingham, Mich.

JESSUP, B. H., Htg. & Vtg. Contractor, Richards & Jessup Co., Inc., Stamford, Conn.

KAUFMAN, H. J., Htg. & Vtg. Engr., Commonwealth & Southern Corp., Jackson, Mich.

KINDORF, H. L., Chief Engr., Edward B. Ward & Co., San Francisco, Calif.

LAFFOLEY, L. H., Asst. Engr., Canadian Pacific Rly., Montreal, Que., Can. *(Advancement)*

MOORE, W. R., Br. Mgr., Minneapolis-Honeywell Reg. Co., Atlanta, Ga.

MURPHY, W. A., Gen. Mgr., Watts Regulator Co., New York, N. Y. *(Reinstatement)*

OWEN, J. D., Culver City, Calif.

PARK, J. F., Sales Engr., Western Air & Refrigeration, Inc., Los Angeles, Calif. *(Advancement)*

PRATT, F. J., Marine Engr., U. S. Navy Yard, Bremerton, Wash.

RABER, B. F., Prof. Mech. Engrg., University of California, Berkeley, Calif.

ROCK, G. A., Partner, Forbes & Co., Miami, Fla.

ROSS, RODERICK, Consulting Engr., Melbourne, Australia.

SHEFFIELD, R. A., Owner, Air Cond. Engrg. Co., Cambridge, Mass.

SIEGEL, W. A., Supervising Engr., York Ice Mach. Corp., St. Louis, Mo.

STROCK, CLIFFORD, Assoc. Editor, Industrial Press, New York, N. Y. *(Advancement)*

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TUTTLE, G. H., Combustion & Htg. Engr., Detroit Edison Co., Detroit, Mich. *(Advancement)*

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WARD, E. B., Air Cond., Edw. B. Ward & Co., San Francisco, Calif.

WEBB, J. S., Sales Engr., W. D. Cashin Co., Boston, Mass. *(Reinstatement)*

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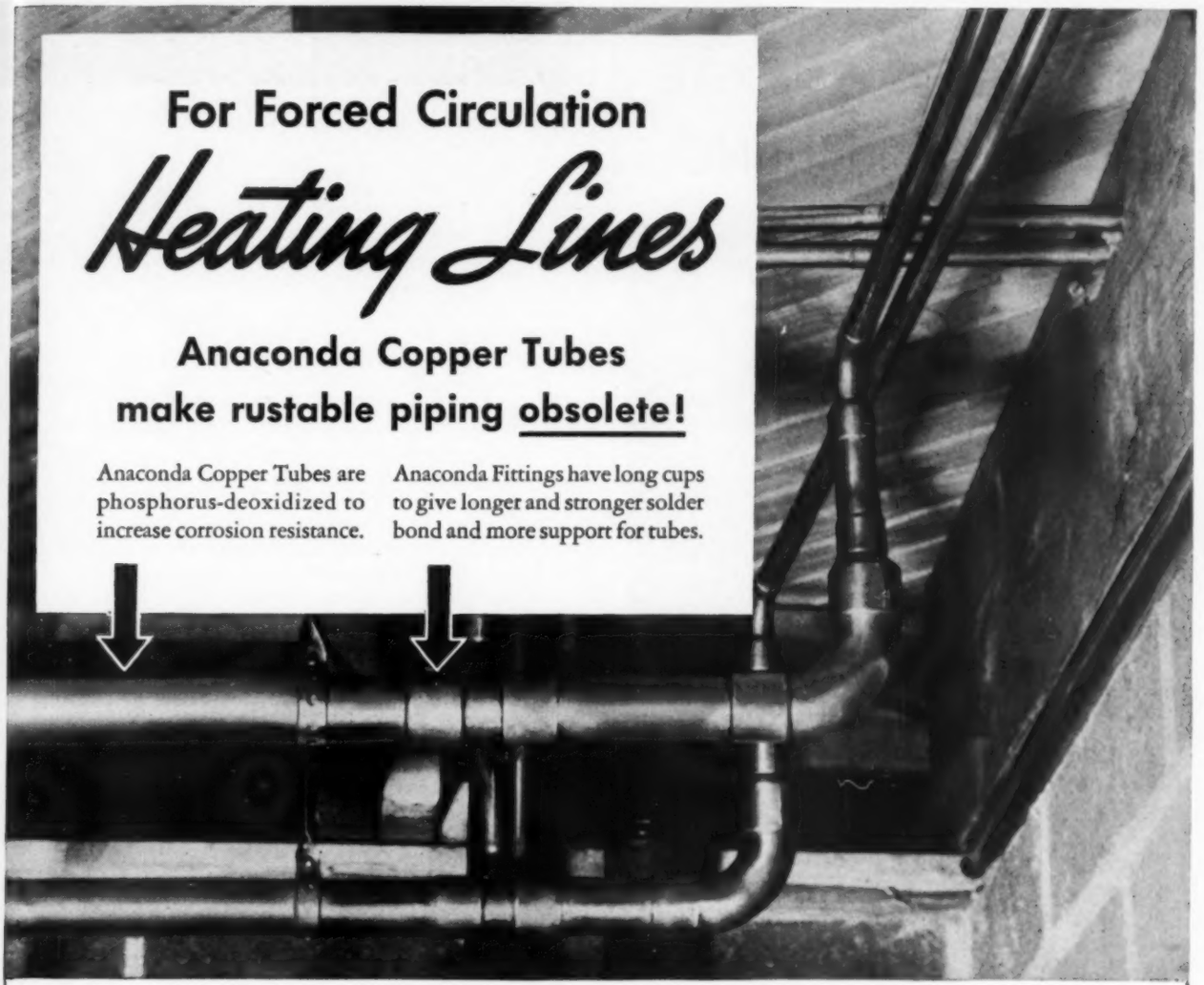
STUDENT

WESTPHAL, N. E., Student, Purdue Univ., West Lafayette, Ind.



For Forced Circulation

Heating Lines

Anaconda Copper Tubes make rustable piping obsolete!

Anaconda Copper Tubes are phosphorus-deoxidized to increase corrosion resistance.

Anaconda Fittings have long cups to give longer and stronger solder bond and more support for tubes.

HERE'S the best value and the most attractive appearance in piping for hot water heating installations with forced circulation.

Reduced resistance to flow. The permanently smooth interiors of copper tubes and fittings reduce friction . . . give 10% to 15% greater velocity of circulation with the same head.

Smaller-size tubes. The faster flow through copper makes it possible to use smaller-size tubes and fittings.

Heat losses are less. Usually, the heat given off by uninsulated copper lines is no more than desirable for heating the basement.

Cost little more. An installation of Anaconda Copper Tubes and Fittings costs very little if any more than piping that rusts.

Anaconda Copper Tubes and Anaconda Solder-type Fittings in sizes from ⅛" to 8" are available at leading supply houses. There is an Anaconda copper-tube fitting for *every* heating requirement.

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from mine to consumer

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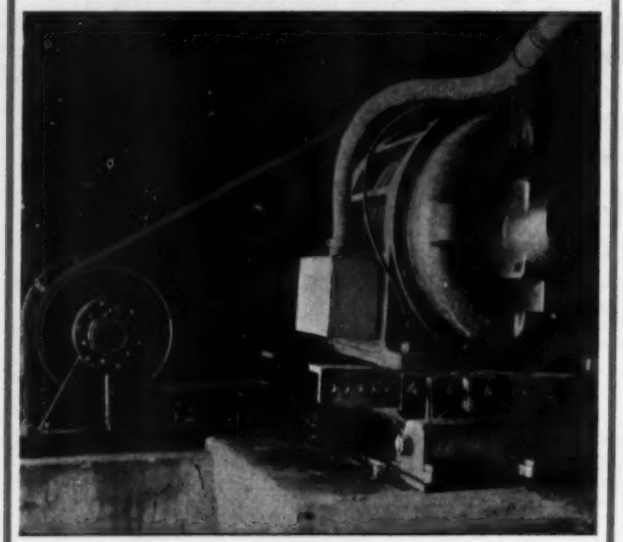
RHOADS TANNATE LEATHER BELTING



SPLENDID RESULTS ON A TOUGH DRIVE

The above is a close-up of a short-center vacuum fan drive that was a very real problem. The equipment originally furnished was a multiple V-belt drive on 56" centers from a 100 H.P. motor. A speed of 3250 r.p.m. of the fan impeller shaft was required. With this set-up it was impossible to get more than 2900 r.p.m., because the belt speed of 6000 f.p.m. forced the V-belts out of the grooves enough to make them slip badly.

After a disappointing trial of this installation, the motor was mounted on a Rockwood pivoted motor base and belted with a Tannate Flat Leather Belt. This arrangement gave a dependable belt speed of 6250 f.p.m. and the required fan speed of 3250 r.p.m.

The flexibility and unusual power-transmitting capacity of the Tannate Belt, together with the automatic tension afforded by the pivoted motor base solved this very difficult problem. The drive has been in successful operation for more than a year.

It is such service as this belt is giving that makes so many users feel that Tannate Belting is unusually efficient and economical.

J. E. RHOADS AND SONS

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FACTORY and TANNERY, Wilmington, Del.

Book Reviews

A New Book on Oil Burners

"Oil Burners," by Kalman Steiner, President, Ace Engineering Co., and Chief Engineer, Consumers Petroleum Co., 1st ed. 1937. 436+ *xvi pp.*, 6x9 *in., clothbound. Published by McGraw-Hill Book Co.,* 330 *W. 42nd St., New York, N. Y. Price,* $4.50.

Mr. Steiner has written a much-needed and complete treatise on oil burner practice which will doubtless take its place as a—if not *the*—standard work on the subject. His choice and arrangement of material is most fortunate, and his style is very clear and readable.

The general plan of the text is "to state the fundamental principles from which the subject matter of the chapter is to be built up, and then to proceed rapidly through what would be ordinarily an elaborate development of theoretical material to the pertinent conclusions." The author thus strikes a middle course between theory and practice. He also stays very close to his subject, it not being his intention to consider the nature or characteristics of the complete utilization of heat, but rather only the efficient liberation of heat from fuel oil.

The first chapter is a treatment of hydrocarbons and petroleum and the second of fuel oil, with the necessary chemistry explained "painlessly." There follows a valuable third chapter on combustion of fuel oil.

That the field of oil burners and oil firing is adequately covered is indicated by the chapter titles. After Chapter 3 they are: Comparative fuel data; problems of oil burner design; domestic oil burners; commercial oil burners; industrial oil burners; fans and electric motors; electric controls; ignition methods; fuel oil pumps and pumping; oil piping, strainers, and flow regulators; combustion chambers for heating plants; industrial boiler plant installations; preheating fuel oil; oil storage tanks and gauges; service and maintenance of domestic and commercial burners; the shell type vaporizing burner; and control of the heating system. A 38 p. appendix includes numerous tables and data of interest.

The author's name will be familiar to readers of HEATING, PIPING AND AIR CONDITIONING, for he has written a number of articles on oil burning and related subjects which have been published during the past several months.

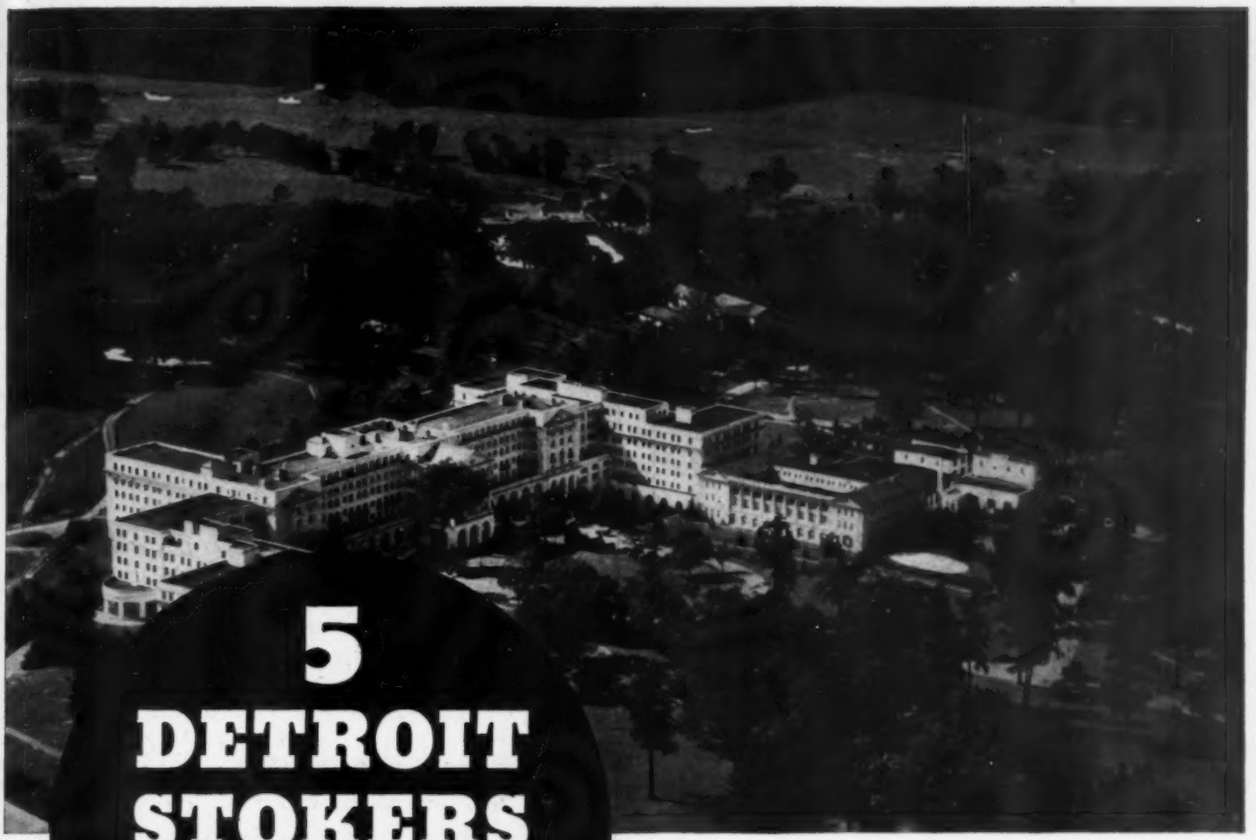
A Handbook on the Degree Day

"Degree Day Handbook," by Clifford Strock and C. H. B. Hotchkiss. 2nd ed. 1937. 298 *pp.*, 6x9 *in., semi-flexible binding. Published by the Industrial Press,* 148 *Lafayette St., New York, N. Y. Price,* $3.00.

Intended to be useful to the operating engineer as a guide to operating efficiency of the heating plant, and to the designer in estimating the fuel consumption of buildings, this new handbook consolidates degree day data which has been accumulated over a period of years.

There are 14 reference tables, the most extensive of which is a 60 p. listing of the normal number of degree days, by months, for 1064 cities. The figures are based on averages covering periods from 10 to 50 years.

In addition to the tables, there is given much other information of pertinent interest. This includes definitions of the degree day and its use, and chapters on heating values of fuels, fuel required per degree day, design temperatures and heating season data, heat carrying capacities of ducts, efficiency of fuels, use of the degree day as a guide to operating efficiency and in sales promotion, and data used in calculating summer cooling loads. This last chapter includes a count of the number of hours the dry bulb temperature was above 75, 80, 85, 90, 95, and 100 F for each of the summer months of the past five years for 18 cities.

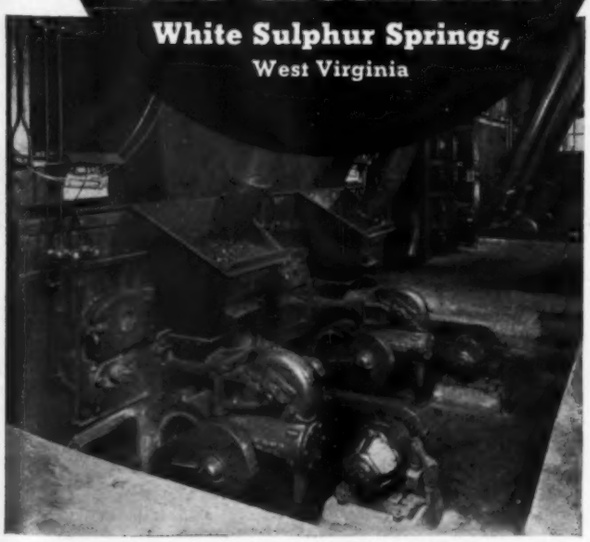


5 DETROIT STOKERS

In the Power Plant

The Greenbrier

White Sulphur Springs,
West Virginia



Greenbrier Boiler Plant showing Detroit Stokers

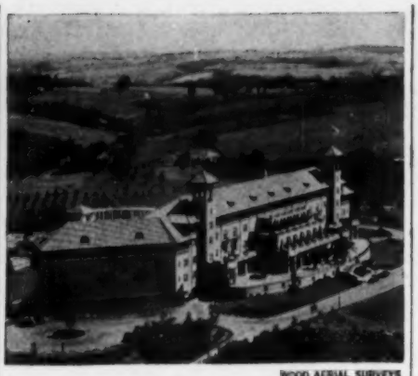
● The FIVE boilers in the famous Greenbrier at beautiful White Sulphur Springs, W. Va., are all equipped with Detroit Stokers, because they offer a large measure of fuel economy, reliability, and freedom from operating troubles.

Ability to burn coal without smoke was a very important consideration in this lovely spot. Detroit Stokers are serving many of such installations with satisfactory performance.

WRITE FOR BULLETIN No. 678

DETROIT STOKER COMPANY

Fifth Floor, General Motors Building, Detroit, Michigan • Works at Monroe, Michigan
District Offices in Principal Cities • Built in Canada at London, Ontario



WOOD AERIAL SURVEYS

Hotel Hershey, Hershey, Pa.

HEATING SATISFACTION IN NEW HOTEL HERSHEY

Owners Provide for Comfort of Guests with Webster Moderator System

MODERN IN EVERY DETAIL

Hershey, Pa.—Hotel Hershey, built in 1933 to provide luxurious accommodations for the thousands of visitors to this great sports center, achieves perfectly balanced heating service with a pneumatic-type Webster Moderator System of Steam Heating.

One of the show places of the East, the 200-room Hotel Hershey is modern in every detail.

"The Webster Moderator System is typical of the fine equipment that we have installed to insure the comfort of our guests," explains Joseph Gassler, Managing Director of the Hotel. "No expense has been spared to make our accommodations the finest possible."

The importance of effective heating is increased by the Hotel Hershey's exposed location in the center of a 10,000 acre farm in the foothills of the Blue Ridge Mountains.

During the severest weather, the Webster Moderator System has met every demand made upon it. Heat is distributed evenly and rapidly to all sections of the Hotel through accurately sized Webster Metering Orifices. A Webster Outdoor Thermostat adjusts the rate of steam delivery with every change in temperature or wind direction. A manual Variator allows the operator to adjust the steam supply to meet special conditions, such as heating up or reducing the night heating load.

J. F. Snavely, the Operating Engineer, says: "The Hotel is evenly heated at all points. There is no overheating during periods of mild weather and practically no loss of heat from window opening."

After experience with the performance of the Webster Moderator System in the Hotel Hershey, a Webster System was installed in the Community Inn, another property of the Hershey Estates.

These before-and-after facts point the way to maximum comfort and economy in heating new buildings as well as in modernization of existing installations. Consult your architect, engineer or heating contractor. Or address

WARREN WEBSTER & CO., Camden, N. J.
Pioneers of the Vacuum System of Steam Heating
Representatives in 60 principal U.S. Cities—Est. 1888

WEBSTER MODERATOR CONTROL "Control by the weather"

Duct Construction

"Duct Construction," by O. W. Kothe, Director, St. Louis Technical Institute. 1st ed. 1937. 270 pp., 5⅜x8 in., clothbound. Published by the Sheet Metal Publication Co., 45 W. 45th St., New York, N. Y. Price, $3.00.

In this book the author has shown approved methods of fabricating and erecting sheet metal work in connection with air distributing systems commonly used in heating, ventilating and air conditioning. The work, therefore, may be classified as a handbook for sheet metal men in connection with the work on pipe, ducts, elbows, transitions, other fittings; housings for fans, heaters, coils and air washers; hoods, dampers, diffusers, the attaching of grilles, etc.

Naturally, the text deals with the various types of seams that are used in the foregoing work. It also includes instruction on how to make turn-blades in elbows, fan connections, the insulation of ducts, etc.

New Arc Welding Handbook

"Procedure Handbook of Arc Welding Design and Practice," published by The Lincoln Electric Co., 12818 Coit Rd., Cleveland, Ohio. 4th ed. 1937. 819+ xii pp., 6 x 9 in., flexible binding. Price, $1.50 *in U. S. A.;* $2.00 *elsewhere.*

This edition includes the latest weld symbols adopted by the *American Welding Society* in May and a new introduction to part six, "Designing for Arc Welded Steel Construction of Machinery." The weld symbols occupy 16 pp., and they are reproduced *in toto* as adopted by the Society. In addition to the symbols themselves, an example is given of how the symbols are actually applied in producing a welded design.

The handbook is divided into eight principal parts: Part 1—Welding Methods and Equipment. Part 2—Technique of Welding. Part 3—Procedure, Speeds and Costs for Welding Mild Steel. Part 4—Structure and Properties of Weld Metal. Part 5—Weldability of Metals. Part 6—Designing for Arc Welded Steel Construction of Machinery. Part 7—Designing for Arc Welded Structures. Part 8—Typical Applications of Arc Welding in Manufacturing, Construction and Maintenance.

The subject matter is indexed in 13 pp.

Schools and Study Courses

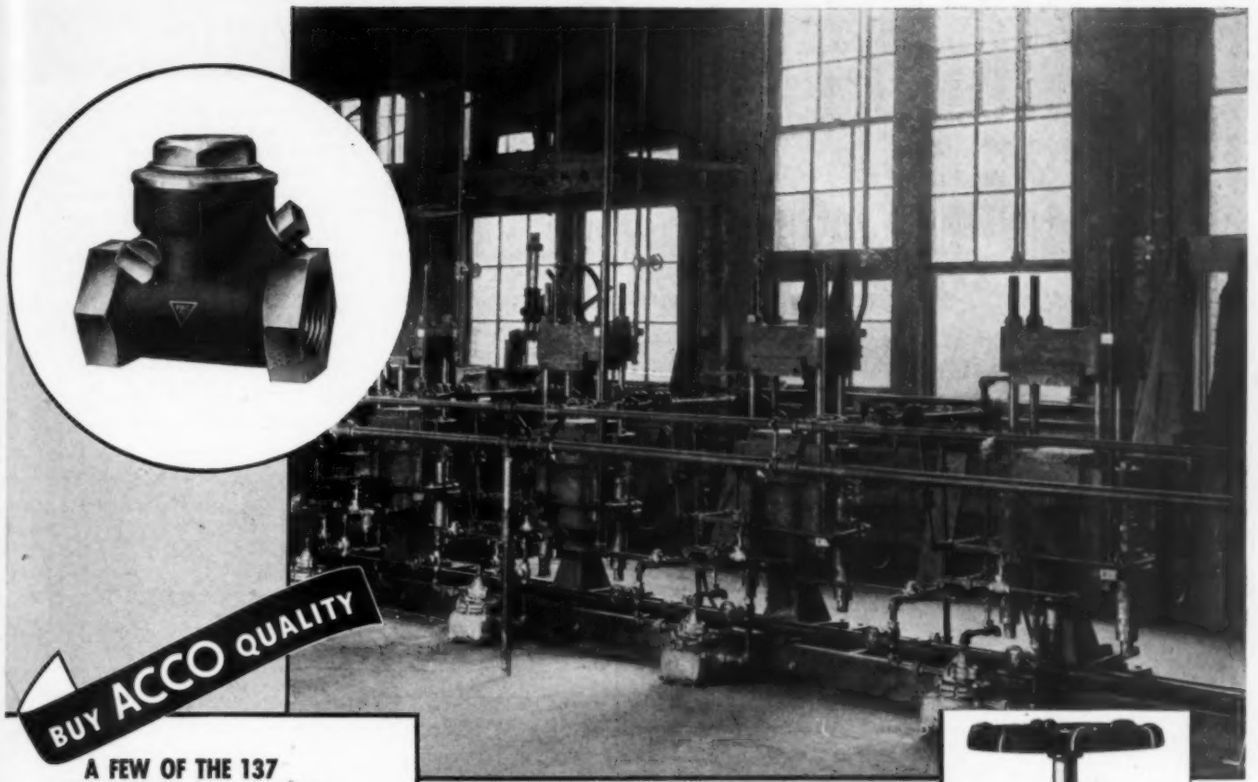
Year 'Round Air Conditioning Course

In a supplementary "report to the industry," the Refrigeration and Air Conditioning Institute, 2150 Lawrence Ave., Chicago, Ill., describes its new course in year 'round air conditioning, enrollments for which started June 1. While the Institute's previous training contained much air conditioning, it was felt that it did not cover sufficiently the subjects of ventilation and heating to meet present-day needs in the air conditioning field.

Following the home study section of the training, the new course requires four weeks of shop work at Institute headquarters instead of two. To provide facilities for the more extensive shop work, and to accommodate 400 students at one time (100 to start each week), the Institute has made plans for a new building and complete equipment for it, which is expected to be ready later this year.

The course is planned so that when the student completes it and has had a little experience, he will be able to completely service an air conditioning system.

Plans have also been formulated for aptitude tests to be used in the selection of students to be sure that those enrolled are properly fitted for the course of training and the work it leads to.



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AMERICAN CHAIN DIVISION
(DOMINION CHAIN COMPANY, Ltd., in Canada)
Weed Tire Chains • Welded and Weldless Chain • Malleable Castings • Railroad Specialties

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PROVED AND *approved* THROUGHOUT INDUSTRY

● The Pratt & Cady Bronze Valves shown here represent one of the countless case records of proved performance in service.

Pratt & Cady Renewable Asbestos Ring Disc Bronze Globe and Angle Valves have been proved and approved throughout industry for over fifty years. They have enjoyed the flattery of much imitation.

Pratt & Cady Valves were well born. This type started off with the advantages of a basic construction so nearly perfect that only three refinements have been possible in all these years . . . a heavier valve to meet increased service pressures . . . a deep stuffing box and follower . . . a union bonnet joint with a bevel between body and hub.

Always ask for Pratt & Cady Renewable Disc Bronze Globe and Angle Valves. They more than meet requirements.

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PERFECT INSULATION

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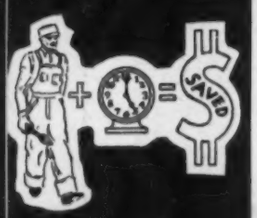
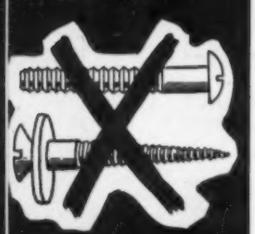


LABOR SAVING

SOUND ABSORPTION



NO SCREWS, LUGS, BOLTS OR WIRE

UNIT PACKAGE . . . NOTHING ELSE TO BUY

NOT *Gone with the Wind*

DUX-SULATION

Fan noise . . . Motor noise . . . or any noise originating in the power room of an air conditioning system, as well as air noises created in the ducts themselves are entirely quieted in a Dux-Sulation insulated duct. Also the possibility of sounds being carried from room to room is removed. Your air conditioning system "Dux-Sulated" means that the only thing flowing out of the registers will be the correct degree of either warm or cool air as desired at that point. It assures quiet operation at all times. Add to this its high insulating efficiency, remarkable flexibility, easy application, moisture-proofness, and indefinite lasting quality, and you will find that Dux-Sulation does any insulating job quicker, better and at a decided saving.

Write for full information NOW.

Dux-Sulation A PRODUCT OF

GRANT WILSON INC

111 TAYLOR STREET CHICAGO, ILLINOIS

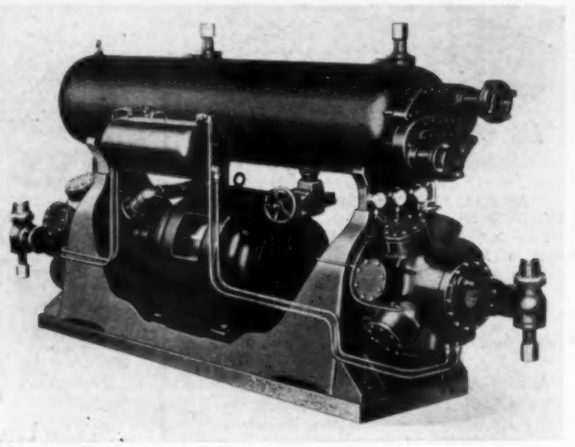
Equipment Developments

For your convenience in obtaining more information about any of this equipment, see coupon on page 134. Add the new products and companies listed here to your Directory Section which you received in your January, 1937, HEATING, PIPING AND AIR CONDITIONING and thus keep your records of sources of supply up to date throughout the year . . . Single asterisk (*) indicates equipment not listed in Directory Section; double asterisk (**) equipment and manufacturer not listed.

Radial Compressors for Air Conditioning Announced

No. 1267—Development of a complete line of high speed "Freon" compressors for air conditioning service that operate at 1750 rpm, utilizing for the first time the radial principle of design, with cylinders placed in a circle around the crankshaft, was announced last month. The first major installation of the new compressors has just been completed to provide air conditioning for the two ballroom and function floors of the Hotel Pennsylvania, New York City.

The units incorporate the same principle of design as that adopted by aeronautical engineers to eliminate motor failure in



airplanes and to increase the motor capacity in proportion to weight, the manufacturer says. They are built in sizes from 10 to 75 hp capacity for commercial installation, and possess a number of practical operating advantages, simplifying problems of installation because they are light in weight, compact in size and free from vibration, it is stated. They can be installed in practically any part of a building, according to C. R. Neeson, who directed their development. At the Hotel Pennsylvania installation, basement space was saved by installing five large size radial compressors in an unused linen storeroom directly over one of the large ballrooms.

Large valve areas combined with small lift are used for quiet valve operation. Another feature which contributes to efficient operation is the use of auxiliary intake ports at the bottom of each cylinder, which are opened by the piston itself, as it completes the downward stroke. The use of the auxiliary ports accelerates intake and thus increases efficiency.

The 75 hp unit is illustrated.—Airtemp, Inc., Leo St., Dayton, Ohio.

Adjustable Feed for Stokers Developed

No. 1268—The adjustable feed illustrated is built into the right hand crank shaft bracket of single retort and "UniStokers." It may be applied to existing installations when desired.

Here's your chance to . . .
EXPOSE YOURSELF TO NEW IDEAS—NEW CONTACTS

● NIAA Conferences never fail to stimulate those who attend. Every session sparkles with new ideas and fresh viewpoints on pertinent problems of the day. Priceless information is passed out freely. Exhibits are educational and inspiring. The good fellowship that prevails fosters new valuable contacts.

The program is designed to benefit not only advertising and sales promotion men, but top executives as well. Leaders in industry will discuss subjects ranging from advertising copy to public and employee relations. Many men who have solved problems that are vexing management everywhere will give you the benefit of their experience. In clinics and at round table discussions they will show you ideas and data they have accumulated. All are fresh, new, applicable to present conditions of management and merchandising.

Could any man concerned in advertising, sales or management spend three days like that without absorbing new ideas, new information, new viewpoints? Do you wonder that men attending these Industrial Advertising Conferences go back to their jobs stimulated and broadened in mind and attitude? Is it surprising that they do a bigger and better job?

Three days take little of your time. The cost is reasonable. The value received is priceless. Surely, you owe it to yourself and to your firm to come. First, you'll want complete information—program details, accommodations, attractions. For convenience, use the coupon.

Write for the facts about the big stimulating program Accommodations—Attractions

USE THE COUPON ➡

NIAA 15TH ANNUAL ADVERTISING AND SALES PROMOTION CONFERENCE AND EXPOSITION
SEPTEMBER · 22 · 23 · 24 · 1937
EDGEWATER BEACH HOTEL · CHICAGO

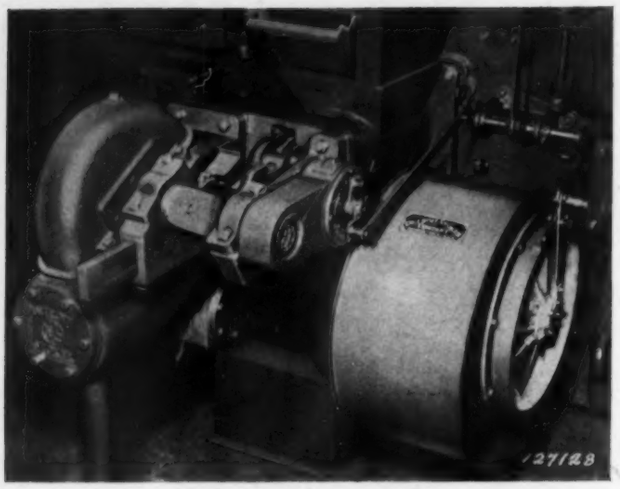
MR. H. D. PAYNE, Chicago Molded Products Co.
2145 W. Walnut St., Chicago, Ill.

Please send me tentative program on industrial advertising and sales promotion of N. I. A. A. meeting ☐ I am going —please register my name ☐

*Name*_____

*Company*_____

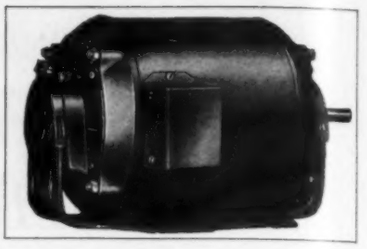
*Address*_____



It may be either manually or automatically operated and offers the advantage of an extremely sensitive control of fuel feed to the furnace over a wide range from zero to maximum capacity, the maker states. If automatically operated, the master regulator which is connected to the adjustable feed may also be connected to the damper at the fan inlet or outlet, so that the air supply is synchronized with the fuel feed, as required by changes in load on the boiler, as indicated by steam pressure variations. The master regulator may also be connected to the boiler uptake damper if desired.—Detroit Stoker Co., General Motors Bldg., Detroit, Mich.

New Fractional Horsepower Motors Offered

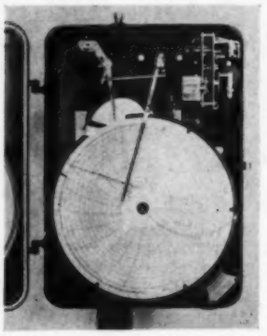
No. 1269—A new complete line of fractional horsepower motors in sizes from 1/6 to ¾ hp, repulsion start induction, single phase, split phase, capacitor, polyphase and direct current, has been announced.



This line is designed with interchangeable mounting dimensions for a given horsepower size. The fundamental principles are the same as have been used by the maker for many years, but a number of improvements have been added.—Century Electric Co., 1806 Pine St., St. Louis, Mo.

Electric Meter Integrator Totalizes Flow

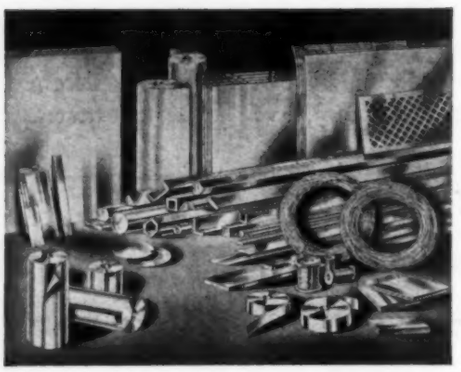
No. 1270—New electric integrator totalizes flow once every 15 seconds. The manufacturer's mechanical and electric flow meters, for measuring the flow of a gas or non-viscous liquid through a closed line, are now equipped with this type of integrator.



A flat disc cam is specially designed to coincide wth the flow law, so that it mechanically computes the square root of the differential pressure across an orifice plate or venturi tube constriction in a pipe line, at 15 second intervals. The values obtained are totalized by means of a counter and are indicated on a six figure integrator dial.

The integrating mechanism consists essentially of a continuously running telechron motor, which operates a counter through

Copper HUSSEY Brass



Sheets and Rolls in all finishes for all types of Air Conditioning Equipment.

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A Division of COPPER-RANGE COMPANY

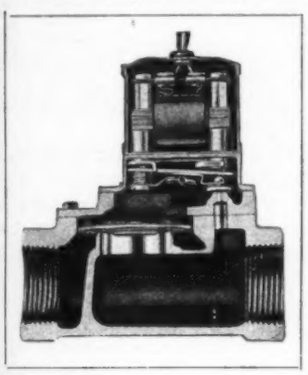
Main Office and Rolling Mills . . . PITTSBURGH, PA.

a train of gears. These are engaged and disengaged by means of a mercury switch and magnet. The cam rider, which is connected through a link to the recorder pen arm, operates the mercury switch in one direction while on the cam and allows it to return to its original position when off the cam. In the latter position the magnet is energized so that the gears are meshed and the integrator is totalizing the computations of flow. Thus, while the telechron motor runs continuously, it operates the totalizer counter only when the gears through the integrator are meshed.—The Bristol Co., Platts Bridge, Waterbury, Conn.

Magnetic Gas Valve Has Many Uses

No. 1271—A new magnetic gas valve for domestic and industrial applications is suitable for gas burning boilers, furnaces, or stoves, for domestic automatic heating or for industrial uses, the maker states. It is also suitable for use with such equipment as gas fired humidifying equipment, etc.

The function of the valve can best be visualized as a valve of the diaphragm type with the diaphragm cut loose from its housing, and made in the form of a small floating disc, which disc floats loosely in the chamber. In the closed position the incoming gas leaks through the clearance around the circumference of the disc, filling the upper chamber with gas at line pressure. As the gas cannot escape through the bleeder the pressure holds the disc firmly on its seat, as there is only atmospheric pressure below the disc.



When the control instrument (thermostat, humidistat, etc.) through the electromagnet, lifts the bleeder valve, the pressure above the disc is immediately released to the down stream side. The incoming gas then lifts the floating disc to the top of the chamber, and as long as the bleeder valve is open it is held up, (1) by the differential of pressure above and below the disc, (2) by the impact pressure from the gas line, and (3) the wiping effect of the gas flowing around the edges of the floating disc. The bleed gas joins the downstream flow in the valve itself, it being unnecessary for the bleed gas to be fed into the burner.

When the control instrument is satisfied and the electrical circuit is broken, the relay closes the small bleeder valve. The flow momentarily continues around the circumference of the floating disc until the pressure in the chamber above the disc equals line pressure, and the disc is then forced down on its seat.

The valve operates on 6 volts.—Julien P. Friez & Sons, Inc., 4 N. Central Ave., Baltimore, Md.

Cork Pads Offered in Convenient Sizes

No. 1272**—"Shock Pads" is the trade name given to cork pads cut in convenient sizes for use under oil burners, fans, blowers, small pumps, and other types of light machinery that transmit vibration.

In many types of buildings, even slight vibration will strike some harmonious frequency, and the humming effect will be amplified as it travels through the building structure, causing considerable annoyance. Transmitted vibration is not always due to faulty machinery. Every machine, like a tuning fork, has a definite frequency when it is in motion. Just as the tuning fork will set in motion another tuning fork of the same frequency, so will a machine in motion set up vibration in any other substance of the same frequency. This is the cause of

You'll Profit by . . . VILTER'S Amazing

Economy Record in Modern Air Conditioning

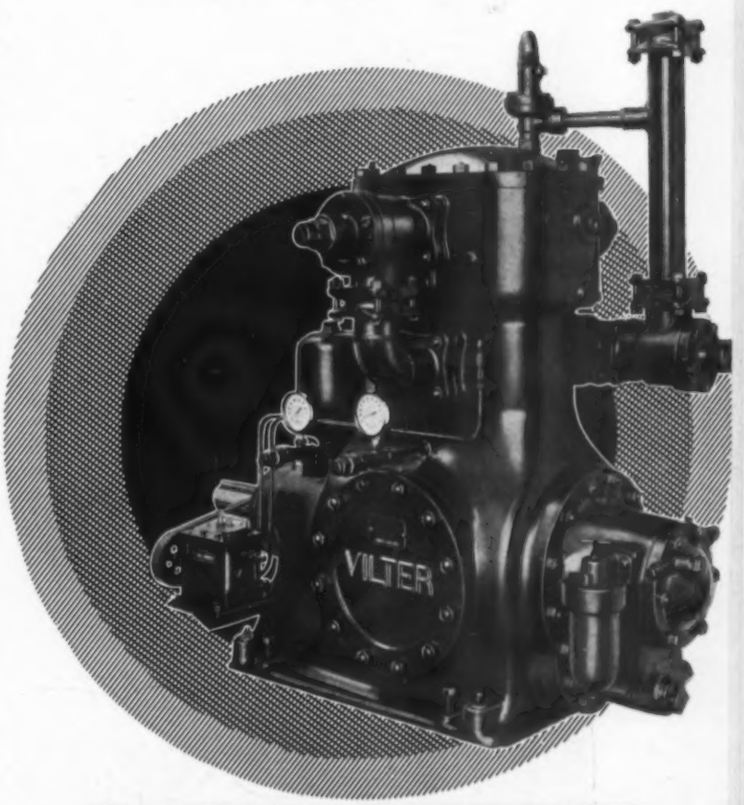
The VILTER "Freon 12" Compressor

Place the VILTER "Freon 12" Compressor on installation. Compare its actual power requirements over any period of time, with a compressor of similar size and rating . . . . You'll get the surprise of your life at the LOW HORSE-POWER PER TON requirements of the new Vilter "Freon 12."

Then You Want to Know How and Why This Is Possible

The secret lies in "freeing" the Vilter of many non-essentials that eat into your power output. . . . Combined with new radical design, and the improvement of construction principles. The result—extremely low relative horse-power requirements—and a new "high" in operating efficiency.

From rich experience of over half a century, Vilter Engineers have achieved, in the "Freon 12" an engineering feat which we invite you to use to your own great profit.



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BALDOR BUILDS *Better Motors*

Where you find AIR CONDITIONING

you find BALDOR *Motors*

AIR-CONDITIONED PULLMANS ARE EQUIPPED WITH BALDOR MOTORS

When the manufacturers of Railway Air Conditioning equipment needed a sturdy dependable motor to withstand extra hard service, under all weather conditions, they chose Baldor Motors.

Baldor has specialized in motors for automatic heating and air conditioning service since the industry began and has pioneered and developed many important advances in motor design and engineering.

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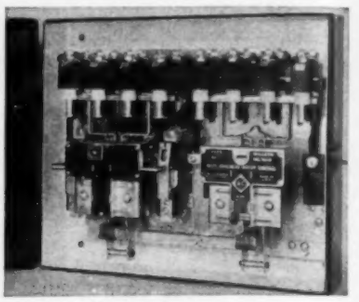
A BETTER MOTOR

many annoying noises so often heard in remote parts of a building.

These pads are made from granulated cork. They have a slow return from compression, and it is this slow return that interrupts any frequency that might be transmitted, says the maker. They come in various sizes, 1, 3, 3¾, 12, and 14 in. diameters, and in two thicknesses, ¼ and ½ in.—B. T. Butterworth, Jr., New Canaan, Conn.

Reversing Motor Starter for 7½ Hp

No. 1273—A new reversing motor starter, designated type AP-7-R, is furnished for 7½ hp, 550 volts, or less. It consists of two motor starter units, mechanically interlocked so that either unit cannot be closed if the other is closed.



These starter units are equipped with "Ruptors," which consist of enclosing chambers to confine and depotentiate the arc formed by circuit interruption, thus increasing the interrupting ability of the contacts and forming individual isolating barriers between contacts of opposite polarity.

Other features are large silver double break contacts, solenoid operated, vertical make and break for silent operation; unit construction, and enclosed temperature overload relays affording positive motor protection; under-voltage protection is inherently provided.—Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Explosion Proof Cases Available for Automatic Controls

No. 1274—A line of explosion proof automatic controls was announced last month. Explosion proof cases for several types of controls are available, being shipped as complete assembled units, ready for installation in danger zones.

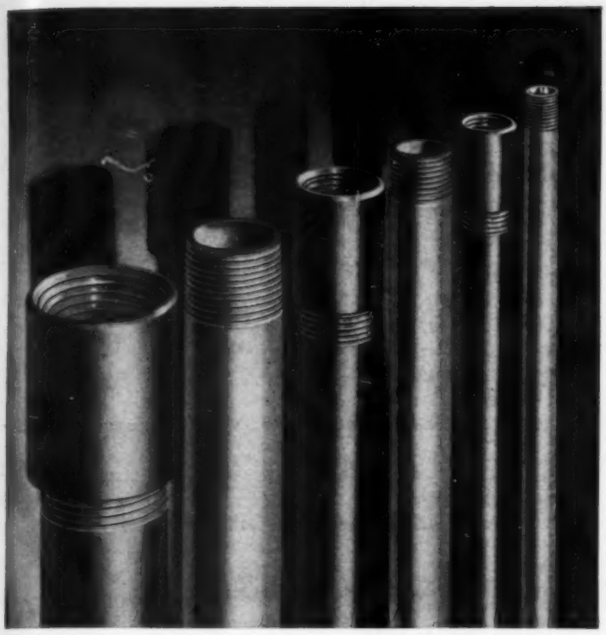
Consisting of a glass tube containing sealed contacts of special material and a quantity of mercury to make or break the circuit when the tube is tilted, the switch used in these automatic controls is built so that there is no open arcing, oxidation or corrosion. But for places so hazardous that double protection against explosion is essential, the new cases are utilized to protect the electrical installation. In such installations, unless the automatic controls are enclosed in explosion proof cases, the complete installation of electrical equipment is not explosion proof.

These controls are produced in several types, for a variety of applications. Pressure controls ranging from 0 to 2500 lb, for use with air, oil, water, steam, ammonia or other chemicals not injurious to brass or steel, are available. Temperature controls for temperatures from minus 30 to plus 450 F are manufactured with explosion proof cases. Transformer relays and lever arm and float operating controls can also be encased to provide complete safety.—Mercoid Corp., 4201 Belmont Ave., Chicago, Ill.

Air Filters for Several Services

No. 1275—A typical exterior multiple installation of two hooded "Multimaze" air filter units is illustrated, with construction details shown in the inset.

This unit is a compact, cleanable metal fabricated air filter of patented construction obtainable in various sizes for internal combustion engines, air compressors, blowers and air condi-



LET'S THROW SOME LIGHT ON THIS MATTER OF *Pipe*

Pipe is probably the most important item in a plumbing system—for without it, how could you have a system—how could you convey water, steam and gas? • Yet pipe probably receives the least thought of any part of the system. To many people, it's just pipe—or steel pipe. • But there is a difference—take Fretz-Moon Pipe, for instance. It is made of clean, coiled skelp of high quality, passed through a special heating furnace which heats it to a definite temperature and then immediately passed through specially designed rolls which form and weld it into a strong, sound tube uniform in every respect, highly ductile and free from hard spots that cause trouble in bending, cutting and threading. Another feature of utmost importance is the fact that during passage through the furnace, never once does it come in contact with the furnace bottom. Thus, it is as clean inside as outside. All mill scale is removed. • If you would use quality pipe at no increase in cost, consider Fretz-Moon.... Ask your jobber or write us.

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TRY FRETZ-MOON PIPE —AND KNOW THE DIFFERENCE

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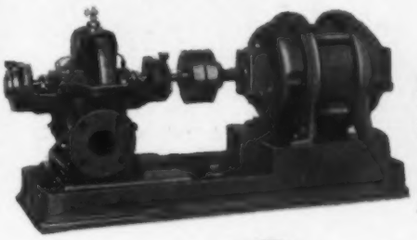
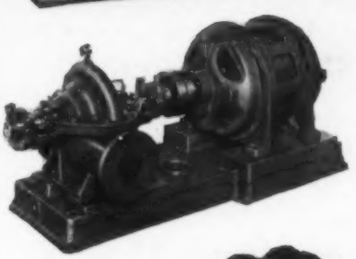
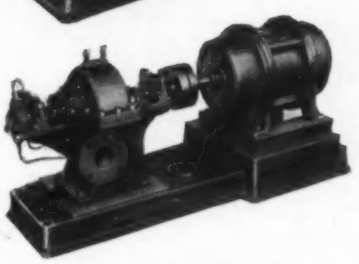
HIGH EFFICIENCY CENTRIFUGAL PUMPS



Type R
Single-Stage...
Single-Suction
40 to 350 gal. per min.
45 to 240 ft. head



Type L
Single-Stage...
Double-Suction
125 to 1700 gal. per min.
30 to 155 ft. head



Type U
Two-Stage...
Single-Suction
25 to 130 gal. per min.
130 to 368 ft. head

- **Horizontally-split Casings** ... Interior inspection without disturbing piping or pump alignment.
- **Heavy Duty**... For the toughest applications.
- **Ball Bearings** ... Negligible friction, lowest maintenance.
- **Volute Casing** ... Of smooth, accurate castings, for maximum hydraulic efficiency.
- **Stuffing Boxes** ... Extra deep and pressure-water-sealed against entering air leakage.
- **Motors Nationally Approved** ... Supplied by Worthington ... Fully guaranteed ... Nation-wide service.

IN STOCK!
Complete with motors
For immediate shipment
from: Chicago, Ill. - New Orleans, La.
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WORTHINGTON PUMP AND MACHINERY CORPORATION
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Made in twin sections so it can be passed through any average door. "No tearing out" necessary. Used extensively for replacements.

The Welded Steel Burnham ranges in capacities from 1800 to 42500 sq. ft.

The Main Reason Is Both Are

Burnham-Built

They are both built two ways. Built to an A.S.M.E. specification. Built to a reputation. One is a *requirement*. The other is an *insurance*.

Both boilers are built in separate plants. One at Elizabeth, N. J. The other at Geneva, N. Y. Nothing about either is farmed out. Neither is an assembled boiler. They are Burnham-Built from top-to-bottom.

Knowing the Burnham reputation is about all you need to know, to know of their out-and-out dependableness.

Burnham Boiler Corporation

Manufacturers of Heating Equipment

Since 1873

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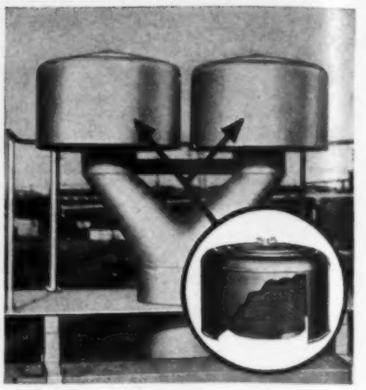
Export Department

116 Broad Street, New York City

Burnham Boiler

tioning systems. Air cleaning efficiency is claimed by the manufacturer to be better than 99 per cent; restriction less than ⅛ in. of water.



For certain types of installations these circular units are more suitable than panel filters, the maker believes. As an instance, the two illustrated handle an air filtration task that would require eight 20x20x4 in. panel filters with frames and weather louvres.

The filter element media may be especially constructed for air cleaning problems where lint or other disturbing factors are encountered.—Air-Maze Corp., 812 Huron Rd., Cleveland, Ohio.

New Welder for Use in Sheet Metal Shops

No. 1276—"Midget Marvel" a-c welder comprises a special transformer and control especially designed for alternating current arc welding. The new set has an operating efficiency averaging 87 per cent at normal loads, according to the maker.

Particularly adapted for use in sheet metal shops, automobile service shops, blacksmith shops, general repair shops, farm work

shops, and other shops requiring light duty welders, the current range of the sets is from 30 to 140 amperes with twelve steps of current adjustment. The secondary open voltage is 50 on low range and 55 on the high. The primary current input for welding at 140 amperes is 70 amperes at 110 volts and 35 amperes at 220 volts and is proportionately lower when welding at lower ranges. The set is designed for use with coated electrodes from 1/16 to 5/32 in. diameter.—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Develops Soldering Flux for Stainless Steel

No. 1277—Features of new stainless steel soldering flux, are that no special soldering equipment or solder is needed and that it does not give off strong, offensive odors or will it severely burn when in contact with hands, the manufacturer reports. It is available in pints, quarts and gallons.—Ruby Chemical Co., 74 McDowell St., Columbus, Ohio.

Branch-Circuit Breakers Announced

No. 1278—A new line of branch-circuit circuit breakers has been announced. They serve both as master control switches, governing groups of lighting or convenience outlets (occasionally both) and as means of overload and short-circuit protection. They eliminate fuse replacements and the practice of

Important to AIR CONDITIONING Contractors and Manufacturers

WITH the growing interest in air conditioning, the development and perfection of air conditioning equipment, and the increased number of installations, the demand for satisfactory air conditioning motors has greatly increased.

Motors to meet this demand are judged largely upon the basis of their efficiency, dependability, performance characteristics, quietness and appearance. Wagner motors are chosen by the leading motor buyers because they embody all the requisites of well-balanced design. Below is shown a Wagner motor equipped with the new type resilient annular-mounting. The boxes and arrows point out a few of its many features.

FRAME AND ENDPLATES are strong and rigid, and accurately machined — assuring permanent alignment of bearings and uniform air gap, two essentials for quiet operation.

STEEL - BACKED BABBITT - LINED BEARINGS are diamond-bored to secure bearing clearances small enough to avoid any possibility of excessive play and at the same time have ample clearance to afford a liberal oil film between shaft and bearing.

BASE consists of formed steel plate. There are no feet to break off in shipment or during mounting.

ROTOR is dynamically balanced to eliminate vibration and noise arising therefrom. The number and the dimensions of rotor slots are carefully chosen to minimize magnetic noise.

Wagner builds a complete line of motors. They are available in any standard horsepower, speed, and voltage rating; in many mechanical variations, such as, flange-mounting, resilient-mounting, double-shaft extension, etc.

On your next air conditioning installation, call in a Wagner sales-engineer for advice regarding the proper motor for the job. Just phone or write the nearest of our twenty-five branches for prompt consultation service.

Wagner Electric

6400 Plymouth Avenue · Saint Louis, U. S. A.

MOTORS · TRANSFORMERS · FANS · BRAKES

M5337-ILA

DON'T WASTE COSTLY FREON

Contraction and expansion strains in straight tubes cause leaks in ordinary water coolers. As Freon turns into a light gas when used, it will pass through the tiniest holes.

Leakage is impossible with Patterson Freon Coolers because the U-tube construction provides for expansion and contraction of each individual tube independently of all others. The entire tube bundle can be removed easily for inspection and cleaning.

Patterson Freon Water Coolers

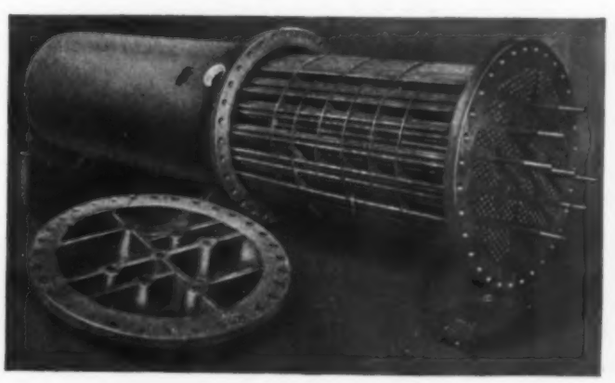
are regularly built with welded steel shells, rolled steel tube sheets, semi-steel expansion chambers and copper tubes and baffles. The COPPER tubes cannot rust or pit and become leaky.

Another important feature is that these coolers may be divided into as many circuits as there are compressors.

Other super-features of Patterson Freon Water Coolers are described in our booklet, sent on request.

The Patterson-Kelley Co., Inc.

107 WARREN STREET EAST STROUDSBURG, PA.



AUDITORIUM
Announces
ROYALTY RATES
*Reduced** AGAIN

IN 1936 —due to the greatly increased number of owners who installed Auditorium Systems, we were able to provide a REDUCTION IN OUR ROYALTY RATE.

NOW . . IN 1937 with another great increase in the number of users of Auditorium Systems, especially of installations below 25,000 CFM capacity and in view of the rapidly increasing volume of sales of Auditorium Licensed Units . . .

Royalties Are Again . . REDUCED*

on a graduated scale on Central Station Systems under 25,000 cubic feet of air per minute and the sizes and types of UNIT AIR CONDITIONERS HAVE BEEN CHANGED.

Auditorium Air Conditioning Systems (the achievements of the leaders in Air Conditioning) with their extensive variety of adaptations, benefits and economies, are now available to you at remarkably small royalty charge.

Our Licensees, listed below, will gladly explain the notable advantages of using Auditorium Systems and the reduced royalty rates. They are prepared to install an Auditorium System for you or give your own contractor permission to do so.

TAKE ADVANTAGE OF THE
NEW LOWER RATES

AMERICAN BLOWER CORPORATION—Detroit, Mich.
BUFFALO FORGE COMPANY—Buffalo, New York
CARRIER CORPORATION—Newark, New Jersey
FRICK COMPANY—Waynesboro, Pa.
GENERAL ELECTRIC COMPANY—Schenectady, N. Y.
J. O. ROSS ENGINEERING CORP.—New York, N. Y.
THE COOLING & AIR CONDITIONING CORP.—(Division of B. F. Sturtevant Co.) Hyde Park, Boston, Mass.
WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY—East Pittsburgh, Pa.
YORK ICE MACHINERY CORPORATION—York, Pa.

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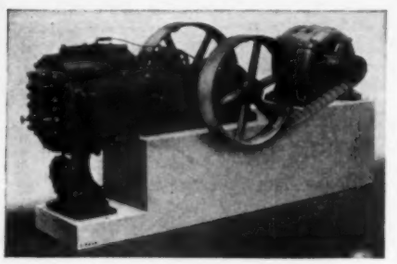
AUDITORIUM CONDITIONING CORPORATION
New York Office—17 East 42nd Street . New York

hazardous over-fusing, and provide accessible localized control at convenient decentralized points for re-establishing circuits opened by overloads or other abnormal conditions.

The circuit breakers have been designed for single pole only, in 15, 20, 25, 30, and 35 ampere capacities, 125 volts, a-c or d-c. The trip free mechanism cannot be blocked by the handle when the circuit is actually overloaded.—General Electric Co., 1 River Rd., Schenectady, N. Y.

Dry Vacuum Pumps Improved

No. 1279—For handling air and vapors not liquified in the condenser, and for pulling a vacuum in any closed system in the chemical and process industries, an improved line of single stage and two stage horizontal dry vacuum pumps, for which high volumetric efficiencies are claimed, is offered.

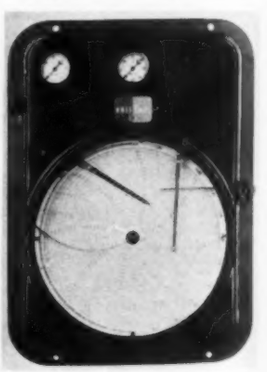


Minimum clearances, necessary because of the direct relation to volumetric efficiency, are maintained by the design of the close-grained, semi-steel vacuum cylinders, the maker states. Other features include large cylinder passages and large valve areas to reduce losses, and head and cylinder water jackets provided with hand holes for easy cleaning. Of particular importance is the special patented feather valve.

These single stage and two stage units are both built in eight sizes. The former have piston displacements of 250 to 2,832 cfm, and the latter of 138 to 1,425. Single stage units are employed for a vacuum of 28 in. or less, and two stage units when a higher vacuum is desired.—Worthington Pump and Machinery Corp., Harrison, N. J.

Round Chart Pyrometer Controller

No. 1280—New round chart pyrometer controller is known as the "Pyromaster" controller. It is a potentiometer pyrometer operating on a simplified principle, and is available in both pneumatic and electric types. It uses standard thermocouples and extension leads, and is for direct ink marking on a round 12 in. chart, or for indicating on a large scale.



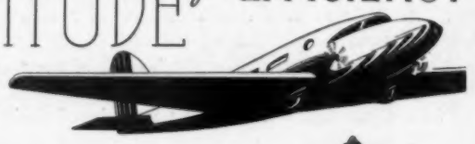
This instrument is available as: A recorder; a recorder with indicating scale; a recorder controller; a recorder controller with indicating scale.—The Bristol Co., Platts Bridge, Waterbury, Conn.

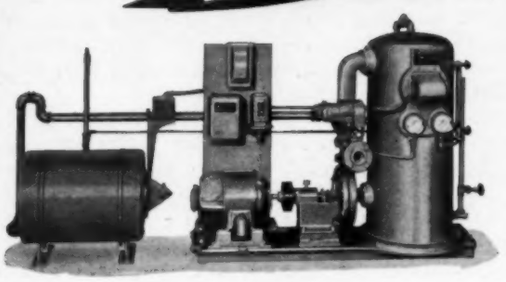
Controls Acid in Fuel Oil

No. 1281—A means developed to counteract acid due to sulphur content of fuel oil consists of a unit placed in the fuel supply line that contains special elements. Two are alloy plates over which the fuel must pass. The unit measures 7 in. in diameter and 11 in. in depth.

The theory of this "fuel dehydrator" is that the acid and moisture creates a "wet battery" action when in contact with the elements of the unit. A measurable amount of current is

ALTITUDE for EFFICIENCY





Third of a Series on the integral appliances used in Dunham Sub-Atmospheric Steam Heating

Like the modern airliner that finds greater comfort for passengers and lower operating cost for its sponsors, as it travels in the rarefied air at high altitudes—so does Dunham Differential Heating safeguard the comfort of occupants and provide for the ultimate in operating economy through its developed ability to circulate rarefied steam generated under the conditions of high altitude—high vacuum.

Such steam, cooler as the vacuum increases, is called SUB-ATMOSPHERIC STEAM. In Differential Heating, vacuum is not confined to return lines nor is it merely a changing phase on supply lines. In Differential Heating Sub-atmospheric steam of a temperature variable with the weather is circulated silently through the system. As it circulates it delivers the required heat-content—no more, no less, to each room. Thus it provides steady comfort. Thus it is able to translate weather mildness into fuel savings.

In addition to the preciseness of its engineering and the ruggedness which characterizes its construction, the Dunham Differential Pump furthers the success of Dunham Sub-atmospheric steam Heating through the ability to maintain high altitudes (high vacuums). The accumulator tank of the pump at all times keeps the system free, at its lowest point, from air and condensate.

Interesting to those charged with building modernization is the fact that many vacuum return line systems may, without replacing steam source, radiation or piping, be converted to Dunham Differential Heating.

DUNHAM Differential HEATING

Consult the Architect for good design and the Consulting Engineer for mechanical equipment.

C. A. DUNHAM COMPANY

450 East Ohio Street **Chicago**

Over 80 Sales Engineers in the United States, Canada and the United Kingdom bring "Dunham Heating Service" as close as your telephone. Consult your classified telephone directory for the address in your city.

HORSE AND BUGGY GOT YOU THERE, BUT-

IN the days of the nag-and-rig, a child could handle the lines. Even today, steam will go through a pipe and get there—some of it. But present-day demands are for streamlined speed and streamlined steam! The modern method of controlling steam in underground lines is—Ric-wiL Conduit. The greater efficiency, durability, and economy of Ric-wiL systems are demonstrated in thousands of installations. Something to think about.

Prevent leakage and loss in your steam lines, keep them tight, dry and 90%+ efficient with a Ric-wiL Tile or Cast Iron System. Ric-wiL service is complete from design to installation and tests, and is nationwide. On any subsoil steam conveyance problem—under-supply, fuel waste, loss in transit—Ric-wiL can give you effective assistance. Write at once for complete catalog and test data.

The Ric-wiL Co., Union Trust Bldg., Cleveland, Ohio
New York San Francisco Chicago
Agents in principal cities

Dry-paC is pure, unadulterated long fibre asbestos, needing no artificial elements, no binder. Absolutely open to inspection during installation.

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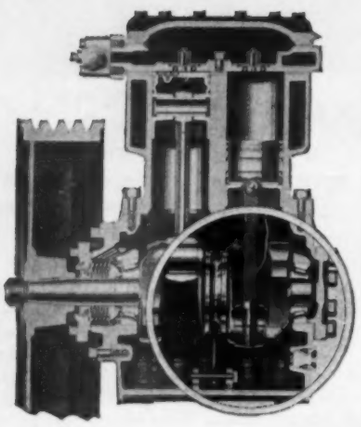
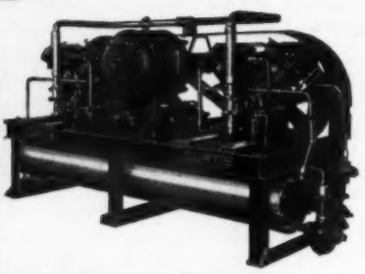
CONDUIT SYSTEMS FOR UNDERGROUND STEAM PIPES

CURTIS
Condensing Units



"CENTRO-RING" LUBRICATION—
—only
CURTIS COMPRESSORS
have it



THERE'S just one moving part in Curtis "Centro-Ring" lubrication—a simple, free running ring that picks up oil from the crankcase and distributes it by centrifugal force under positive, uniform pressure to all points of lubrication — no gears — no plungers — nothing to get out of order or require service.

Engineering superiorities of this kind have built the Curtis reputation for reliability, long operating life and low cost of upkeep.

The Curtis line contains 41 air-cooled units, from 1/6 HP to 5 HP, inc., and 45 water-cooled units from 1/3 HP to 30 HP — a size and type to balance most any installation you might make. Curtis has built condensing units for 15 years and has made engineering equipment for 82 years — a record of success that in itself is sufficient warranty of the high-quality of Curtis units of today.

CURTIS Engineering Refinements

- Centro-Ring — one piece, positive pressure lubrication
- Timken Tapered Roller Bearings
- V-type radial compressor
- Water-jacketed compressor heads and cylinders
- Built-in oil separator with automatic return
- Drop forged, heat treated crankshafts and rods
- Balanced syphon, bellows seal
- Automatic water valves

Represented in Canada by
Canadian Curtis Refrigeration Co., Ltd.
20 George St., Hamilton, Ont., Can.

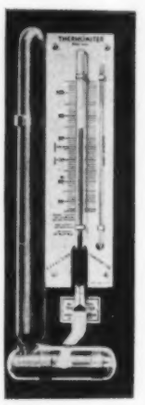
CURTIS REFRIGERATING MACHINE CO.
"Builders of Condensing Units since 1922"
1950 Kienlen Ave., St. Louis, U. S. A.

generated and in so doing the plates are eaten away. After handling from 30,000 to 40,000 gallons of fuel the plates will weigh as little as 10 oz. as compared to 2 lb 4 oz when new. In the process of neutralizing the acid, in the fuel, the moisture is dried out or else settles to the bottom of the unit from which it can be drained.

Diesel truck operators who have equipped their engines with the acid neutralizer report that maintenance on pumps and injectors is now required but every 40,000 to 60,000 miles, whereas, formerly it was necessary to service them at 5,000 to 7,000 mile intervals.

These units are now available for both domestic and industrial boiler installation, and studies to date indicate that firebox rebricking and service work on pumps and burner equipment will be reduced, the manufacturer states. Carbon formation on the burner tips, it is said, will be almost entirely eliminated because fuel with acid removed burns cleaner and combustion is more nearly complete.—Cunningham Co., 4252 Santa Monica Blvd., Los Angeles, Calif.

Indicator for Effective Temperature



No. 1282**—Illustrated is an effective temperature indicator, the "Therhumiter," which has been designed to provide a simple measuring stick for conditioned atmospheres. It will register effective temperatures for air motion up to 150 fpm, according to the maker. The formula for determining the relative humidity from the thermometer readings is engraved on the scale directly on the instrument. —John R. Parsons, 151 E. 19th St., New York, N. Y.

Unit for Cooling Circus Tents

No. 1283**—A unit for promoting the comfort of circus audiences has been invented and is called the "Tent Air Cooler." The device is attached to the eaves of the tent by placing the trailer on which it stands against the side wall of the tent and running a duct up to the vent.

The unit operates on a total of one hp for the blower and

Photograph, Walter Cocker

pump and has capacity to handle an entire section accommodating 360 people, or an area 60 ft long, 9 ft high, and 12 ft wide, the maker reports. The duct is placed above the top seat section and distributes the cool air for 30 ft in each direction. The motors are direct current and are driven by power furnished by the light plant carried by the circus.

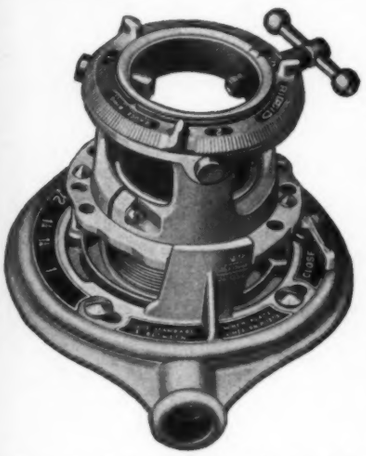
A unit being used by Eddy Bros. circus was tested recently on a day when the outside temperature was 92 F; temperature of the air leaving the duct was 72 F.—Charles J. Meyer, 1 Newark St., Hoboken, N. J.

Boiler Shipped Knocked Down

No. 1284—New "Type KD," or knock down, boiler for oil, coal, and stoker firing, has been designed to meet the need for

ONLY 4 CHASER DIES

INSTEAD OF 16



Shift the setting post (a matter of an instant) and this RIDGID No. 65R is ready to thread 1" or 1¼", 1½" or 2" pipe — without changing dies, with perfect accuracy in every thread variation. One set of dies, and you leave them in — no bother of changing, forget the other 12 dies you don't need to carry and can't misplace.

There are many other features you'll like about the RIDGID No. 65R. Write for the descriptive folder, or see it at your jobber's.

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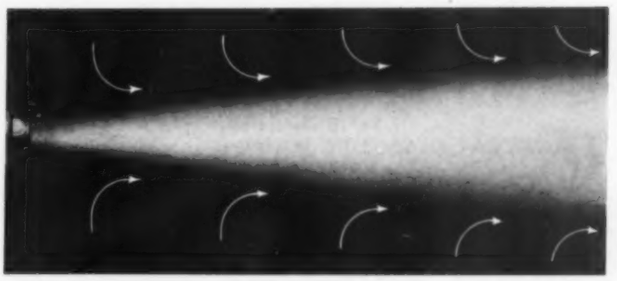

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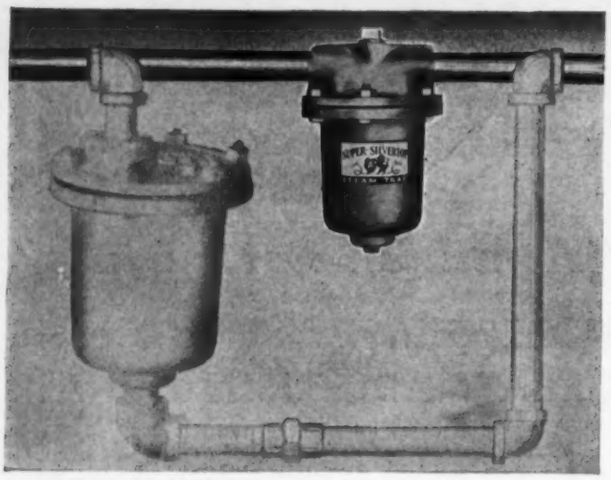

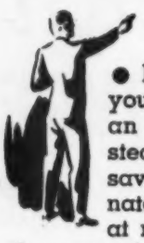

● No fittings are wasted when you pipe straight across, using an Anderson Super-Silvertop steam trap. Look at the fittings saved, think of the labor eliminated. These savings are yours at no extra cost—sometimes at less cost because Anderson Super-Silvertop steam traps average 76% greater condensate capacity than ordinary traps. This usually permits the use of a small Anderson Super-Silvertop instead of a larger ordinary trap that costs more money.

Other features of the Anderson Super-Silvertop trap are: it can be used as an elbow as well as straight-in-line, no extra fittings required; is inspected, cleaned or repaired without removing trap from the line, works on vacuum as well as pressure . . . proof that it does not leak steam; is the only trap that can be equipped with snap action Thermal Air Eliminator for instant heat; no strainer is required.

Anderson Super-Silvertops are the only line of inverted bucket traps that offer complete air elimination at pressures as low as one-half ounce!

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Anderson **SUPER-SILVERTOP**

a boiler that would heat large buildings, where there is no way of getting a one piece steel boiler in the building without excessive cutting and patching. In the knocked down condition, the parts of even a 300 hp boiler of this type may be taken through an ordinary boiler room door or down a fire passage in a basement, says the manufacturer. Erection work is done by the manufacturer's own boiler makers, or by local boiler makers. When set up and turned over to the heating contractor for installation, it is a permanent fixture and carries the same guarantee as the maker's other boilers.

The boiler is of latest water tube design and of rugged construction throughout, the design following that of large power plant water tube boilers. When assembled, the boiler is entirely enclosed by water wall panels and a minimum amount of refractory is required in the casing.—International Boiler Works Co., East Stroudsburg, Pa.

Chain Vise Is Streamlined

No. 1285—A new streamlined chain vise was introduced to the market last month. Features are the pipe rest and pipe bender, frames of special alloy malleable metal, and "no mar" jaws of high quality tooled steel which are hardened for firm grip and long wear.

The available sizes are 2, 4, 6, and 8 in.— Ridge Tool Co., Box 670, Elyria, Ohio.

Sign Agreement on Auditorium Patents

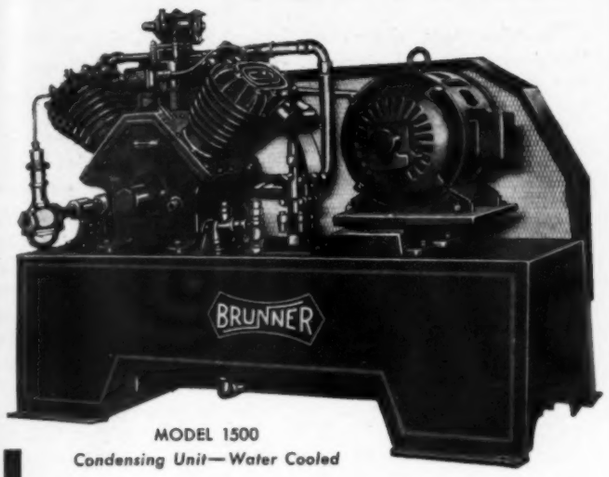
Warner Brothers Pictures, Inc., Loew's, Inc., and National Theaters Corp. have signed agreements with Auditorium Conditioning Corp. ending a period of litigation and uncertainty concerning the "Auditorium bypass patents" and more than a score of others covering various systems of air conditioning for human comfort.

The Lewis Reissue Patent No. 16,611 and Fleisher Patent No. 1,670,656 (now reissued as Re. 20,088), known in the trade as the "bypass patents," have been in the courts for about ten years. They were twice upheld in litigation involving theater air conditioning systems, but in a third suit the District Court held the claims sued upon to be invalid and this was affirmed by the Circuit Court of Appeals. Auditorium Conditioning Corp. disputed this decision and immediately filed another suit in order to get a decision by the U. S. Supreme Court. This suit is now terminated under the agreements recently signed.

Under the terms of the contracts, the theater circuits obtain a license for all their existing air conditioning systems under all patents owned by Auditorium Conditioning Corp. including the "bypass patents," and agree that whenever any patents of Auditorium Conditioning Corp. are used, that the contractor making the installation, extension or reconstruction embodying said patents shall pay to Auditorium the currently established royalty rate.

The coupon on page 134 is designed for your convenience in obtaining more information about any of these Equipment Developments.

NEXT YEAR *at this time*



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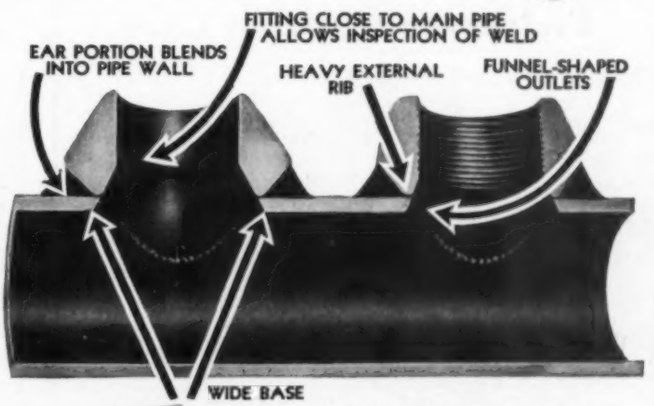
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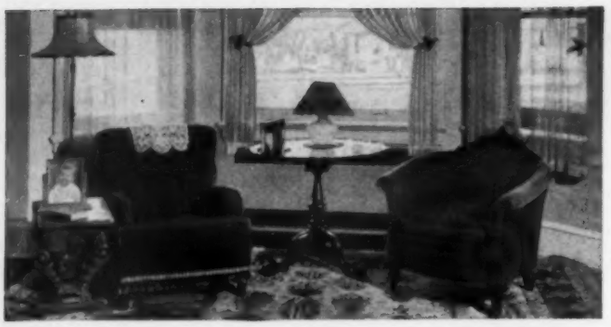

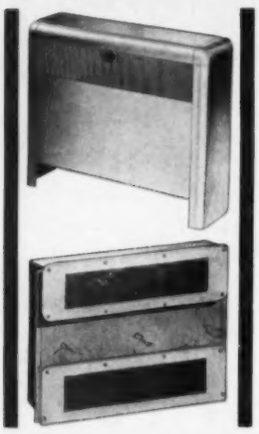

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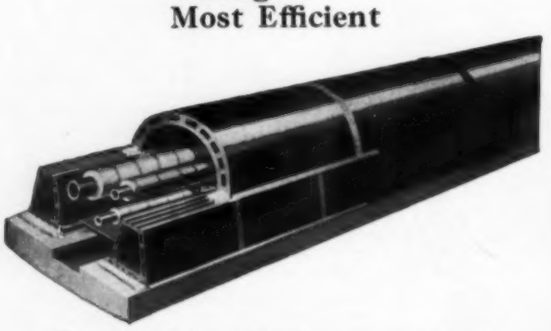

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Booklets, Reports and Papers

Printers Need Air Conditioning

The advantages of air conditioning several Chicago printing plants were summarized by H. H. Slawson in a recent issue of *The American Printer*. The following has been abstracted from this article by permission:

In the Henneberry Rotogravure Corp. dark room, where the etching process begins, things were in chaotic condition during the severe summer weather of 1934. Outdoor temperatures ranged up to 110 F, while the heat inside was unmentionable. The gelatin coating of the carbon tissue paper buckled and blistered or slithered off completely. If the plates for a color job could somehow be produced, efforts to register colors on the presses proved futile because the torrid temperature had changed the paper dimensions abnormally between runs.

Down on the lake front, at the same time, a score of exhibits at a Century of Progress Exposition were demonstrating how air conditioning apparatus can make industry independent of weather conditions. Thus it was not surprising that someone raised the question, "Why not air condition the Henneberry dark room?" Within 24 hours a three ton air conditioning outfit was installed and in working order to service the dark room.

"Over night the change was remarkable," the plant superintendent said. "Our troubles vanished. We felt as if we had been missing something all our lives heretofore."

That dramatic experience sold the Henneberry company on the possibilities of scientific air conditioning in the printing industry. The three ton installation was expanded to a 40 ton system.

In one of the large downtown banks is a printing department with a small air conditioning plant which demonstrates the possibilities of air conditioning in the smaller printshop. This printing department has a staff of ten employees and equipment which includes eight presses, five of which are automatics.

"About five years ago we put in air conditioning," said the manager. "Previously we had been having trouble with the paper, which is chiefly bond and ledger stock. Varying moisture conditions in our basement rooms caused this to curl and wrinkle, with difficulties familiar to all printers. The paper would not feed right on the automatics and the color work would not register. All that was overcome with properly conditioned air. It has had tremendous effect in saving time at the presses and eliminating spoiled stock. It has also been possible to make savings by buying supplies of paper in large quantities, thus getting the benefit of price discounts."

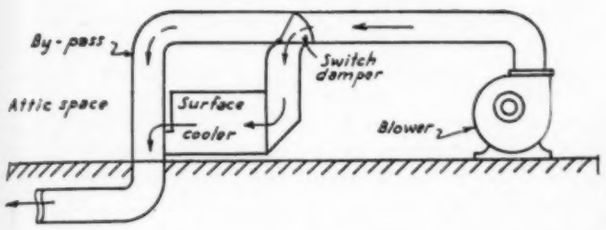
A. F. Cox, superintendent of maintenance for the Manz Corp., contributed another angle to the profit motif of air conditioning in printing plants. The Manz buildings cover a city block. One small system serves the carbon tissue room, but otherwise humidification of press and stock rooms is provided by atomizers near the ceiling. These force live steam into the air to find its way about unregulated.

"I know this to be true," said Mr. Cox, "that with proper humidification it is possible to get longer use out of the rollers. On the high speed presses these sometimes break down quickly and have to be replaced. We have no accurate cost data to substantiate this, but since our atomizer system was installed the rollers have not gone to pieces so fast. We do not have to take them out so frequently."

He pointed out also that properly controlled humidity and temperature keep the composition rollers from swelling or shrinking to cause trouble with blurred plates or light impressions. A constant diameter for the rubber rolls is also essential in offset printing, he added, and he spoke of how humidity at the right degree eliminates static in a pressroom and saves the expense of slipsheeting.

Other evidence of how air conditioning affects printing operations was collected in various places. One printer told how,

INSTALLED in 1899



This sketch is reproduced from an article in Heating, Piping and Air Conditioning, June 1936 issue, by G. Richard Ohmes and Arthur K. Ohmes. It is a diagram of an air system, with Carbondale Refrigeration, installed in the*

Cornell Medical College
New York City

It is believed that this may be considered as one of the first air conditioning installations in a hospital.

Since 1899, when this system was installed, Carbondale has made many successful refrigeration installations, not only in hospitals, but in all other fields. Carbondale has also won wide recognition as builders of air conditioning equipment that is efficient, economical and thoroughly reliable.

Regardless of the size or location of the hospital or the rooms that are to be air conditioned, Carbondale engineers stand ready to confer with you, and to explain the new and better Carbondale features, without obligation.

*Described in Engineering Record, October 5, 1901

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POMONA TURBINE PUMPS

after two months' experience, they made comparisons.

"We had absolute production records on jobs we had handled for a number of years," he said, "and we found that our present production was increased from 8 to 10 per cent. This, we know, is due to the proper conditioning of the paper.

"Recently also, we completed several folding jobs, including some 'over-over' folds where the strain is terrific on the last fold. Heretofore we had never been able to produce finished pieces without cracking the edges of the last fold. This problem has been entirely eliminated and folding production has been increased 10 per cent by actual records."

By comparison of records on duplicate jobs it was found in the same plant that ink consumption was reduced 5 per cent. The ink had a much better flow, giving absolute, even distribution and resulting in perfect printing. Clarifying this statement, one manufacturer of air conditioning apparatus points out that while humidity has no direct effect on the ink itself, it does affect the way in which paper takes ink.

Another printer, speaking of the effect of air conditioning on rollers, said his records show that during a run of 10,000 on a high class monthly publication it was formerly necessary to stop and wash up five times. Now the runs are completed without any washups, due to proper roller conditions, plus freedom from dust in the air which used to find its way to rollers and forms.

Some striking data are offered by the engineers of one manufacturer to explain some of the troubles commonly experienced by printers. In damp air, as is well known, the cellulose fibers of paper swell, causing the sheet to become longer and wider. When the moisture evaporates into the air, the sheet contracts.

Changes in temperature can produce changes in relative humidity of from 65 per cent to 6 per cent in unconditioned pressrooms over a period of one month. In August relative humidity frequently varies from 17 per cent to over 90 per cent and it can change as much as 40 per cent in a single day.

With a change of 30 per cent in relative humidity, a 38 in. sheet of coated paper will vary approximately one-sixth of an inch. With a humidity change of as little as 5 per cent a 25x38 sheet will stretch as much as $\frac{1}{32}$ of an inch in 20 minutes.

If three colors of a four color form have been run off and then that 20 minute stretching period happens along what are the chances of registering the fourth color?

This situation explains why makeready time in "natural weather" shops seldom complies with the time allowed by estimates or competitive bids. The largest return on an investment in air conditioning, the engineers figure, "will be from the decrease in non-chargeable hours caused by deformities of paper." Under the stress of present competition, air conditioning thus becomes an important cost factor.

Regarding the health aspect, there is general agreement that air conditioning in any industry promotes the comfort and well-being of those who work under artificially created weather conditions.

"Air conditioning is becoming daily more essential to the printing industry," says Supt. Cox of the Manz Corp. "In some departments, such as color printing, it is indispensable to the highest class of work.

"In old buildings, however, installations are costly. If an air conditioning system can be built into a printing plant as it rises new from the foundation, the cost will be much less.

"The ideal industrial building of the future is going to be one of those structures that has no windows. Air conditioning will, of course, be essential, but it will prevail not for the building's sake alone but because it will play a practical part in printing operations."

NO MAINTENANCE TROUBLES WITH this UNIT HEATER

The first Grid Unit Heaters made in 1929 are still in operation on steam pressures from 2 to 250 lbs. — without upkeep expense. Here's why: The "fin" or heating sections are special aluminum alloy, cast in one piece with the high test iron steam chamber—a construction that cannot be affected by electrolysis . . . no brazed, soldered, expanded joints . . . no unions nor seams . . . a unit built to last indefinitely, and made in sizes for all installation requirements of suspended type heating. Complete details on request.

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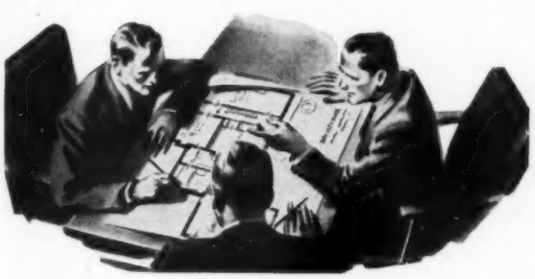

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Final costs considered, the use of Revere Copper Tube in place of rustable material adds little to total building costs and provides a permanently efficient piping system that will add materially to the investment and functional value of the completed structure. Attractive and modern appearance is a further asset, of appreciable importance where piping is exposed. Write for special booklet—"Revere Copper Water Tube."

Revere Copper *and* Brass

FOUNDED BY PAUL REVERE 1801

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EXECUTIVE OFFICES: 230 PARK AVE., NEW YORK CITY

Rely on A-P Controls to run Your Air Conditioning Jobs

With increasing frequency, air conditioning installers are reporting better performance from their A-P equipped units.

Reasons for this are found in the care and accuracy with which every A-P control is made — the patience and severity with which it is tested

No. 73 RB Solenoid

Easy to Service

Leave on the line, remove bottom nut and parts drop into your hand for cleaning and inspection.

Brass forged bodies are used on these valves to eliminate possible leakage.

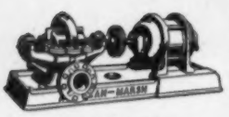
No. 210 Expansion Valve

AUTOMATIC PRODUCTS COMPANY

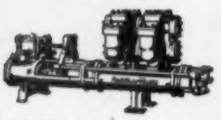
2460 NORTH THIRTY-SECOND STREET

MILWAUKEE WISCONSIN

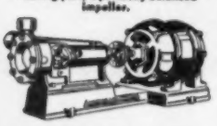
We Change Our Name!



CENTRIFUGAL PUMPS . . Split and solid case types.



TURBINE PUMPS . . Only one wearing part, a perfectly balanced impeller.



STEAM PUMPS . . Simplex and Duplex types in all practical sizes.

Years ago our old name—American Steam Pump Company—was entirely appropriate, for then we made steam pumps only.

But now we also build centrifugal pumps, turbine pumps and power pumps for many services.

And so to better associate our Company name with our long established trade name — American-Marsh — by which most of our equipment is known, we have recently changed our Company name to that used in the signature below.

However, there has been no change in financial structure . . . no change in management . . . no change in quality standards maintained for more than 60 years . . . no change in address.

May we be favored with your next pumping inquiry?

AMERICAN-MARSH PUMPS, INC.

Centrifugal, Turbine, Steam, and Power Pumps

BATTLE CREEK . . . . MICHIGAN

Welding fittings at their best

WELD your pipe lines—for added safety and added strength with lighter weight—for smooth-flow interiors—for smooth, sightly, easily insulated exteriors. Taylor WeldELLS head the list of Taylor Forge *Engineered* Welding Fittings. They are reinforced at the crotch where strain is greatest—have tangents which remove the weld from the curved section—have machine tool bevelled welding surfaces which permit sound, dense welds.

The Taylor Forge line covers every need. It is the most complete line made.

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Also made from BYERS GENUINE WROUGHT IRON PIPE

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WeldELLS

SEAMLESS PIPE FITTINGS FOR WELDING

Conventions and Expositions

Universal Craftsmen Council of Engineers of the World: Power show and mechanical exposition, August 3-7, Hotel Stevens, Chicago, Ill. General Chairman, W. T. Walters, 7965 Phillips Ave., Chicago, Ill.

National Association of Power Engineers: Convention, August 30-September 3, Jefferson Hotel, St. Louis, Mo.

American Gas Association: Annual convention, September 27-October 1, Hotel Cleveland, Cleveland, Ohio. Headquarters Office, 420 Lexington Ave., New York, N. Y.

Association of Iron and Steel Engineers: Convention and exposition, September 28-October 1, Hotel Stevens, Chicago, Ill. Headquarters Office, Empire Bldg., Pittsburgh, Pa.

Chicago Exposition of Power and Mechanical Engineering: October 4-9, International Amphitheatre, Chicago, Ill. Under management of the International Exposition Co., Grand Central Palace, New York, N. Y., manager of the biennial National Expositions of Power and Mechanical Engineering, the next of which will be held in New York City December 5-10, 1938.

American Public Health Association: Annual meeting, October 5-8, Hotel Pennsylvania, New York, N. Y. Headquarters Office, 450 7th Ave., New York, N. Y.

American Welding Society: Annual convention, week of October 18, Hotel Traymore, Atlantic City, N. J. Headquarters Office, 33 W. 39th St., New York, N. Y.

Metal and Welding Exposition: Week of October 18, Convention Hall, Atlantic City, N. J. American Society for Metals, 7016 Euclid Ave., Cleveland, Ohio.

Refrigeration Service Engineers' Society: Annual convention and exhibit, November 3-5, Hotel Stevens, Chicago, Ill. Chairman, Herman Goldberg, 9 S. Clinton St., Chicago, Ill.

American Petroleum Institute: Annual meeting, November 9-12, Hotel Stevens, Chicago, Ill. Headquarters Office, 50 W. 50th St., New York, N. Y.

Chemical Industries Exposition: December 6-11, Grand Central Palace, New York, N. Y.

Fifth International Heating and Ventilating Exposition: January 24-28, 1938, Grand Central Palace, New York, N. Y. Manager, Charles F. Roth, International Exposition Co., Grand Central Palace, New York, N. Y.

American Society of Heating and Ventilating Engineers: Annual meeting, fourth week in January, Biltmore Hotel, New York, N. Y. Secretary, A. V. Hutchinson, 51 Madison Ave., New York, N. Y.

American Society of Refrigerating Engineers: Annual meeting, January 26-28, Roosevelt Hotel, New York, N. Y. Secretary, David L. Fiske, 37 W. 39th St., New York, N. Y.

Recent Trade Literature

For your convenience in obtaining copies of bulletins, see coupon on page 134.

No. 2455. AIR DISTRIBUTION: Anemostat Corp. of America, 551 Fifth Ave., New York, N. Y. 16 p. catalog on the "Anemostat," a device for providing draftless air distribution in which room air is mixed with conditioned air, permitting high velocities and large temperature differentials. Features of this air diffuser are described in some detail, a number of installations are illustrated, and a large capacity table with instructions for its use is presented.

No. 2456. AIR DISTRIBUTION. Kelvin & Wilfred O. White Co., 90 State St., Boston, Mass. 24 p. catalog on "Thermotank" punkah louver system of air delivery, with a discussion of the

MONARCH
RE-COOLING NOZZLES

Monarch Fig. B-8 and B-8-A cast Brass nozzles, for cooling condensing water in spray ponds, use no internal vanes or deflectors which might facilitate clogging. Available in capacities up to 104 G.P.M. at 10 lbs.

For industrial air washers we recommend our ¼" Fig. 631 (female) or ¼" or ⅜" Fig 629 (male pipe) delivering 64 G.P.H. at 20 lbs. pressure.

For air conditioning work our all brass Fig. F-27 (⅛" or ¼" female pipe) or Fig. H-261 (¼" male pipe) nozzles produce a very fine spray using city water pressure.

Write for New Catalog 6-A

Fig. B-8

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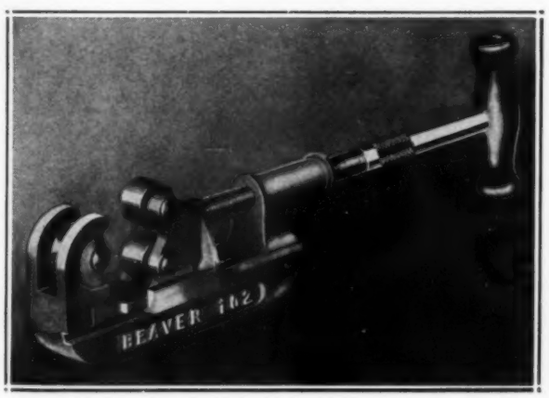
2723 E. Westmoreland St., Philadelphia, Pa.



Air Furnace MALLEABLE Iron--
It Won't Break!

Patented surface-ground construction. All parts at exact right angles to each other—therefore guaranteed to track. Made of Air Furnace MALLEABLE iron—to withstand severe abuse. Three types of wheels available—(1) standard pipe, (2) cast iron pipe, (3) thin wall tubing. Wheels and rollers are standard and interchangeable with other tools.

No. 102—⅛ to 2" one wheel cutter $3.30; 3-wheel $3.60. No. 204—2½ to 4" 3-wheel only $10.00. Buy through your jobber.

BEAVER PIPE TOOLS

837 KEENEY AVE. WARREN, OHIO

The *AIRBLANKET* Definitely Reduces Heating Cost

. . . because only the AIRBLANKET brings below breathing level comfort with above breathing level economy.

This amazing unit heater does not rely upon fins, louvers, deflectors or other ordinary devices to retain the heat in the working zone. An entirely different principle, using a high velocity of cool air to roll the stream of warm air down against the floor provides absolute control of the warm air.

Ten Years Success

During the past ten years many of America's "Hardest-to-Heat" buildings have been comfortably and economically warmed by this simple, proven method of heat distribution . . . the Exclusive *AIRBLANKET* Method.

Don't buy any unit heater until you have secured full details on the *AIRBLANKET*.

Correctly Engineered Unit Heaters by Airtherm

Capitalizing thirty years research and experimentation Airtherm Engineers have produced the ultimate in unit heater efficiency and design. In addition to the *AIRBLANKET*, the Airtherm Line includes the Airvector (Fan Driven Units) and the Airheator (Blower Driven Units)...both of which embody many new, exclusive features in unit heater construction and performance.

Write for full details of the Airtherm line including the *AIRBLANKET*, at once.

The AIRBLANKET is available for ceiling or floor mounting.

AIRTHERM MFG. CO.
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FOR DEPENDABLE PERFORMANCE USE *Randall* BEARINGS

The Randall Standard Pillow Block, fastest selling bearing of its type in the industry, gives dependable, trouble-free service over a long period in use.

It is self-aligning, self-lubricating, clean and *quiet* in operation and with a minimum of attention will last practically a lifetime.

The *quiet* operation of Randall bearings eliminates metallic bearing noise throughout the system.

A catalog illustrating and describing the complete line of Randall Pillow Blocks will be sent free on request.

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McQUAY COMBINATION
COOLERS and HEATERS
for
Year 'Round
AIR CONDITIONING
Using cold water or brine for cooling, or, hot water or steam for heating. The ideal unit for simplified air conditioning applications.
Send for special descriptive bulletin on Combination Coolers and Heaters.
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Write for descriptive catalog on McQuay Unit Coolers, Comfort Coolers, Copper Radiation (Convectors), Air Conditioning Coils, Blast Coils, Refrigeration Coils, Ice Cube Makers, Combination Heating and Cooling Units (Suspended and Floor Types), Cabinet Floor Type Room Coolers, etc.

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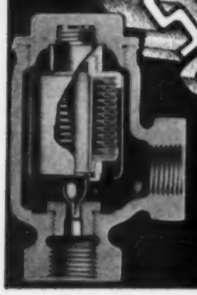
Removes condensate and air as soon as formed. Cannot air bind or freeze. Self-adjusting for pressures 0 to 200 lbs. Works on steady or fluctuating pressures. Sold on 30 days' trial. Write for Catalog 0-95.
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FILTER PANELS
● 99.3%—99.8% Efficient
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AIR-MAZE
CLEANABLE AIR FILTER PANELS

principles, dimension drawings, capacity charts, and illustrations of a number of installations.

No. 2457. BLAST HEATERS: Modine Mfg. Co., 17th St., Racine, Wis. 48 p. catalog and technical data book on blast heaters, with a description of the features, design and construction details. Dimension diagrams, physical data, many engineering tables arranged for easy use, and reference examples of blast heater selection are given in detail, and drawings of various types of systems are shown.

No. 2458. CONDENSATE RETURN UNITS: Cameron Pump Div., Ingersoll-Rand Co., 11 Broadway, New York, N. Y. 8 p. bulletin on "Cameron" condensate return motor pump units describing features and giving capacity data.

No. 2459. CONTROLS: Mercoid Corp., 4201 Belmont Ave., Chicago, Ill. 16 p. brochure entitled "Built To Endure" describing this company's controls, among which are the "Sensatherm" thermostat, limit and low water controls for steam boilers, temperature limit controls, warm air furnace controls, and sealed mercury contact switches.

No. 2460. CONTROLS: Perfex Controls Co., 415 W. Oklahoma Pl., Milwaukee, Wis. Two new price sheets, one on controls for the stoker industry and the other on controls for the oil burning industry. Illustrations of each control are shown, a brief description of the application of each is given, and a complete catalog listing is tabulated.

No. 2461. CONTROLS: Ranco, Inc., 601 Fifth Ave., Columbus, Ohio. Catalog sheets on temperature and pressure controls, steam boiler controls, and room thermostats.

No. 2462. COOLING COILS: Young Radiator Co., 709 Mead St., Racine, Wis. 12 p. catalog on cooling coils for use with water or brine, including dimension drawings and capacity tables for the various units, tables and curves for the selection of coils for cooling service, and a number of examples showing in detail how to select the proper coil for various types of systems. Piping diagrams are included.

No. 2463. ELECTRIC HEATERS: Harold E. Trent Co., 618 N. 54th St., Philadelphia, Pa. Catalog sheets on unit electric heaters with fans and electric vane strip heaters, the latter for promoting convection of free air, heating air streams, or heating liquids. Accessory equipment is also described.

No. 2464. EVAPORATORS: Bush Mfg. Co., 100 Wellington St., Hartford, Conn. 56 p. catalog of individual fin evaporators, comprising tables and data on the various types of coils, and giving list prices.

No. 2465. FANS AND ROOF VENTILATORS: Johnson Fan & Blower Corp., 1319 W. Lake St., Chicago, Ill. 12 p. bulletin on propeller fans and roof ventilators, describing the features of the "Health-aire" propeller fan, and giving capacity tables and specifications and similar information on the motor driven "Health-aire" roof ventilator. Other products on which information is given include automatic shutters, safety guards, penthouses, and man cooling fans.

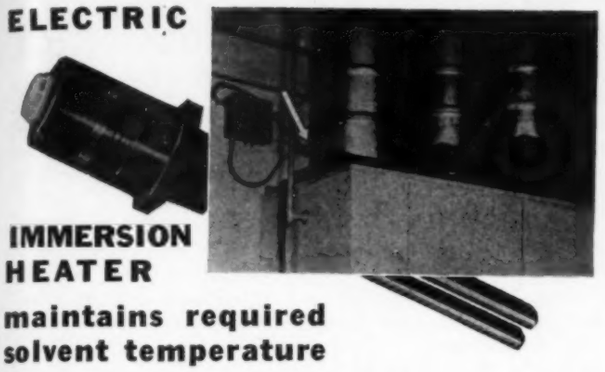
No. 2466. GASKET MATERIALS: E. I. du Pont de Nemours & Co., Inc., Rubber Chemicals Div., Wilmington, Del. 20 p. booklet on "Neoprene," an engineering material with rubber-like properties which resists the deteriorating effects of heat, sunlight, chemicals, and oxidation. Applications are described, including hose, moulded parts, sheets, and gaskets.

No. 2467. INSTRUMENTS: C. J. Tagliabue Mfg. Co., 340 Park Ave., Brooklyn, N. Y. 56 p. catalog of "Tag" indicating and recording temperature and pressure instruments, with data on indicating and recording controllers for temperature and pressure, recording thermometers, recording pressure gauges, and dial indicating thermometers. Numerous installations are shown of the application of these instruments in the process industries, and features of the instruments are illustrated.

No. 2468. INSULATIONS: Keasbey & Mattison Co., Butler Ave., Ambler, Pa. 32 p. booklet on "K & M" insulations, illustrating and describing each, and giving information on uses. A cross index is included.

CHROMALOX

ELECTRIC IMMERSION HEATER



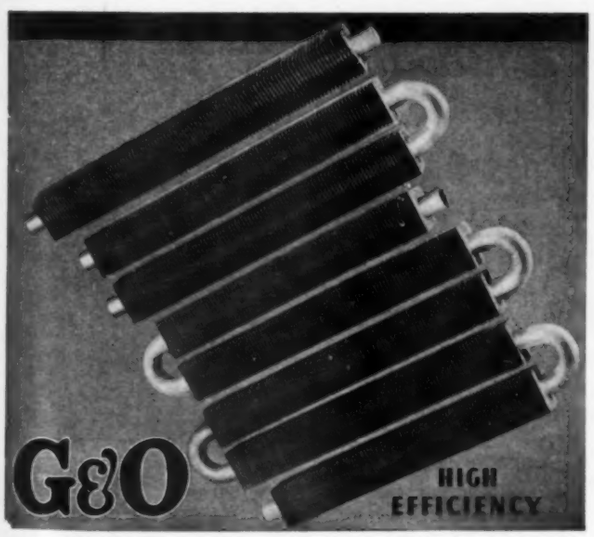
maintains required solvent temperature

The two farther drums in the above photo contain solvent which feeds by gravity into the nearer drum, on the left. Here the solvent is heated by a 3-Kw. 230-volt Chromalox electric immersion heater installed near the bottom of the drum. By means of simple thermostat control the contents of the drum are always ready for use at exactly the temperature required, with no care or attention needed.

Every plant has situations where this type of service would be profitable. Whether it be the heating of liquids, semi-liquids, solid materials, gas, air, parts of machines, processes, *it can be heated electrically,* by Chromalox units and the desired temperature automatically maintained—all with the additional advantages of convenience, lowered fire insurance rates, compact and neat installation, and operating economy.

Except in special cases the Wiegand Company sells the heating units only. Our engineering staff gladly cooperates with you in working out methods of applying them. Send us a rough sketch and description of your heating problem. Keep the Chromalox Catalog on file for ready reference. On request.

EDWIN L. WIEGAND COMPANY
7610 Thomas Blvd. Pittsburgh, Pa.



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WE are splendidly equipped to supply high efficiency Finned Tubing and Complete Coils for all heat transfer purposes.

Special Shapes, Bends and Continuous Coils

Correspondence invited.

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ACCURATE

Low thermal inertia • Adjustable heat acceleration • Silver and chrome finish

A PRODUCT OF GENERAL CONTROLS
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ORIGINATORS OF THE QUIET A. C. SOLENOID

Only the "YOUNG" REGULATOR has all 4 FEATURES

1 LOCKS SECURELY
2 TAMPER-PROOF
3 POSITIVE ACTION
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Patented

The "YOUNG" Regulator will give you EVERYTHING that is expected of a good damper regulator. You can balance the system quicker, and when dampers are locked, they stay SECURELY LOCKED. They are tamper-proof which prevents system from being thrown out of balance. The "YOUNG" Regulator is specified by leading Architects and Engineers because it is the only regulator having all of the four important features necessary for 100% satisfaction. USE IT ON YOUR NEXT JOB.

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No. 2469. LUBRICATION: Texas Co., 135 E. 42nd St., New York, N. Y. Issue of "Lubrication," Vol. 23, No. 7, devoted to a discussion of counteracting the effects of water by selective lubrication.

No. 2470. METERING. Bristol Co., Platts Bridge, Waterbury, Conn. Bulletin on telemetering and remote control by means of the "Metameter," explaining in diagrammatic form how these instruments measure, transmit and record readings over a two wire circuit where the receiver and transmitter are any distance apart. Pressure, liquid level, flow and temperature may be remotely controlled.

No. 2471. OIL BURNERS: Ace Engineering Co., 1735 W. 31st St., Chicago, Ill. 12 p. bulletin on "Uniflow" horizontal rotary oil burners for the efficient burning of heavy fuel oils, with a complete description of features and applications. Typical installations are illustrated.

No. 2472. OIL BURNERS: Williams Oil-O-Matic Heating Corp., 1201 E. Bell, Bloomington, Ill. 68 p booklet entitled "The 10 Majors" giving a wealth of information on the combustion of fuel oil, the laws of combustion and heat transfer, flame placement, CO_2, and discussing the principle and cycle of operation of this company's burner. Features of the equipment are discussed in detail and many boiler burner and furnace burner units are illustrated and described. Additional data on heating capacities and other information is given for new models. The concluding pages give data on estimating oil consumption, industrial applications, importance of good insulation, etc.

No. 2473. PACKINGS: Keasbey & Mattison Co., Butler Ave., Ambler, Pa. 32 p. booklet on packings of numerous types with information on the application of each, and a helpful reference table of packing recommendations.

No. 2474. PIPE: Phelps Dodge Copper Products Corp., British American Tube Div., 40 Wall St., New York, N. Y. 4 p. bulletin on "Bulldog" hot forge, extruded brass and copper pipe, with information on the features and tables of weights and gauges.

No. 2475. PIPE COILS: Rempe Co., 340 N. Sacramento Blvd., Chicago, Ill. Data sheet on three types of bends and fabrications—spirals, ovals, and flats. Various types of coils are illustrated.

No. 2476. PUMPS: Roots-Connersville Blower Corp., 16th St. & Columbia Ave., Connersville, Ind. 4 p. bulletin on cycloidal rotary pumps particularly adapted to handling heavy liquids, describing features and giving ratings.

No. 2477. PUMPS: Roots-Connersville Blower Corp., 16th St. & Columbia Ave., Connersville, Ind. 4 p. bulletin on positive priming of centrifugal pumps, including in addition to listings of some sizes, pertinent tables of technical data.

No. 2478. PUMPS: Yeomans Bros. Co., 1433 N. Dayton St., Chicago, Ill. 20 p. bulletin on automatic electric heavy duty bilge or sump pumps for drainage, flood water, boiler blow off, hot wells, hot sodas and acids, etc. Information is given on selection, and construction features, specifications, and selection charts are presented.

No. 2479. RADIATORS: American Radiator Co., 40 W. 40th St., New York, N. Y. 6 p. bulletin on "Corto" radiators, discussing their advantages and giving dimension and rating tables.

No. 2480. REFRIGERATION INSTRUMENTS: James P. Marsh Corp., 2073 Southport Ave., Chicago, Ill. Folder illustrating and describing various refrigeration instruments, including service thermometers and gauges.

No. 2481. REFRIGERATING UNITS: Frick Co., Waynesboro, Pa. 12 p. bulletin on low pressure refrigerating units furnished in 50 types and sizes with motors ranging from ¼ hp and up. Data on various applications, including air conditioning, and design and construction are given.

No. 2482. STORAGE HEATERS: Quaker City Iron Works, Inc., Aramingo Ave. & Ontario St., Philadelphia, Pa. 8 p. bulletin on storage heaters, giving complete tables of dimensions and capacities, large drawing of details and features, and discussing construction.

INDEPENDENT "Fabrikated" REG. U.S. PAT. OFF.

adjustable
DIRECTED AIR FLOW
REGISTERS and GRILLES

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THE INDEPENDENT REGISTER CO.
3757 E. 93rd ST., CLEVELAND, OHIO

Fairbanks Valves

are never balky. They don't meet their owner with a smile one day and with a snarl the next.

They won't bind or stick. Release instantly. Close tightly. Outwear the pipe line. Lower up-keep cost is assured.

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The Fairbanks Company
Distributors in Principal Cities
396 Lafayette St. New York, N. Y.
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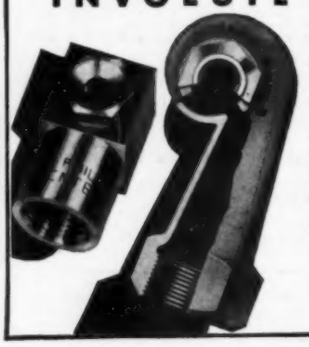
YARWAY
INVOLUTE NOZZLES



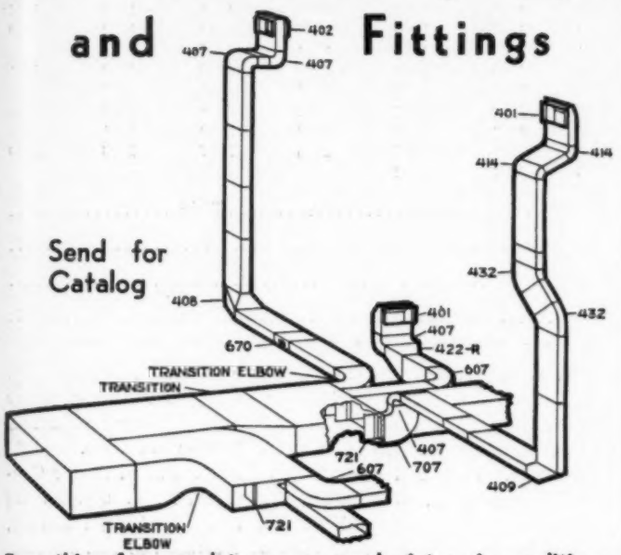
The preference for trouble-free air washing service — because there are no internal parts or vanes to wear or clog. Proven through many years of service in water cooling and air conditioning installations totaling more than 5 million g. p. m.

Made in sizes and types for all requirements. Ask for Bulletin N-615.

YARNALL-WARING CO., PHILA.
MERMAID & ANDERSON STS.

MONCRIEF

Air Conditioning Pipe and Fittings



Everything for complete summer and winter air conditioning installations. Made with special Moncrief lock joints. The product of 39 years experience in the manufacture of pipe and fittings. Send for Catalog.

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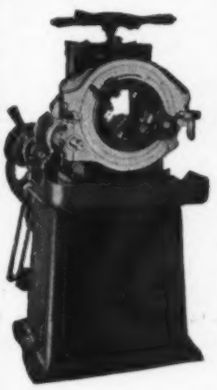
Pipe Threading and Cutting Machines

Cut more threads per Dollar Invested . .

OVER FIFTY YEARS EXPERIENCE



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SMALL FLOOR SPACE
LESS POWER USED
CUTS BENDS
SELF OILING
ADJUSTABLE AND OPENING DIES
LESS PRICE

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LEWIS' NEW
"Air Conditioning for Comfort"
by SAMUEL R. LEWIS

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Large Psychrometric Chart

So understandably does this new volume cover all angles of air conditioning that already dozens of schools teaching air conditioning have adopted it as a text. From it anyone may quickly acquire a thorough knowledge of equipment, psychrometry, refrigeration, humidification, dehumidification, heat transmission, heat absorption, air distribution, and water circulation. It also explains every step in the design of a complete heating and cooling system for a typical residence and a typical commercial building.

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- A typical KANE installation, of which there are thousands. Every one a tribute to the built-in efficiency of their operation; every one on the job, every day . . . delivering a constant pressure of clean steam with but the very minimum manual regulation.

In each installation of KANE Gas Fired Steam Boilers there is a tremendous saving over a period of time—both in fuel costs and in labor. Its aggregate economies soon pay for the unit. *That is the reason it is so widely used by cost-conscious operators and so enthusiastically recommended by them.*

It's easy to "check"—just write us for details.

(And, for a small—1 to 5 H. P. —inexpensive, unjacketed boiler, you'll want details of the MKAYO. Ask about it, too.)

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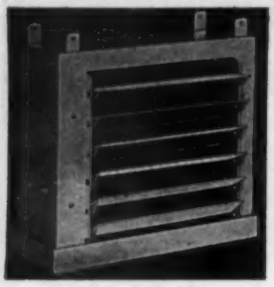


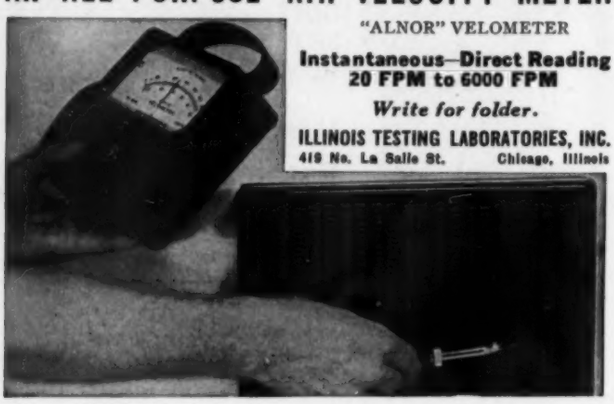
UNIT BLOWERS
Pipe Coils
Air-Conditioning Coils

FIN COILS
5/8"-3/4"-1"
Steel or Copper

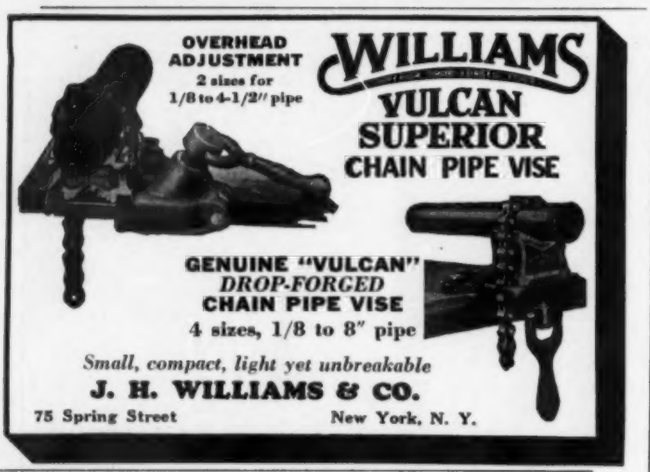
REMPE

Rempe Company
340 N. Sacramento Blvd., Chicago, Illinois

AN ALL PURPOSE AIR VELOCITY METER



"ALNOR" VELOMETER
Instantaneous—Direct Reading
20 FPM to 6000 FPM
Write for folder.
ILLINOIS TESTING LABORATORIES, INC.
419 No. La Salle St. Chicago, Illinois



OVERHEAD ADJUSTMENT
2 sizes for 1/8 to 4-1/2" pipe

WILLIAMS
VULCAN SUPERIOR
CHAIN PIPE VISE

GENUINE "VULCAN"
DROP-FORCED
CHAIN PIPE VISE
4 sizes, 1/8 to 8" pipe

Small, compact, light yet unbreakable
J. H. WILLIAMS & CO.
75 Spring Street New York, N. Y.

BAKER
Automatic self-contained units for freon or methyl-chloride available in 77 models from 1/4 to 60 tons.
BAKER ICE MACHINE CO., INC.
1508 EVANS ST., OMAHA, NEBR.
Branch Factories: Fort Worth, Los Angeles, Seattle
Authority on Mechanical Cooling for Over 30 Years

FOR YOUR CONVENIENCE

Heating, Piping and Air Conditioning,
6 N. Michigan Ave., Chicago, Ill. [8-37]

Please ask the manufacturer to send me more information about the equipment mentioned under the following reference numbers in "Equipment Developments" and "Recent Trade Literature." (Circle the numbers in which you are interested):

1267	1268	1269	1270	1271	1272	1273
1274	1275	1276	1277	1278	1279	1280
1281	1282	1283	1284	1285		
2455	2456	2457	2458	2459	2460	2461
2462	2463	2464	2465	2466	2467	2468
2469	2470	2471	2472	2473	2474	2475
2476	2477	2478	2479	2480	2481	2482
2483	2484	2485	2486	2487	2488	2489
2490	2491	2492				

Name .....Title.....

Company .....

Address .....

City .....State.....

No. 2483. SWITCHES: Micro Switch Corp., Freeport, Ill. Circular on the "Micro" switch for solving out-of-the-ordinary electric contact problems, describing briefly its many applications and giving a specification sheet and dimension drawings.

No. 2484. TUBING AND CONDUITS: Phelps Dodge Copper Products Corp., 40 Wall St., New York, N. Y. 8 p. bulletin on rustless bronze electrical metallic tubing and rigid conduit, with a discussion of the properties of the material and its uses, dimensional and weight data, etc.

No. 2485. TANK HEATERS: Evins F. Glore Sales Corp., 1949 Grand Central Terminal Bldg., New York, N. Y. 16 p. booklet on "Gloco Red Band" tank heaters, including sectional types, describing the various heaters and giving capacity data.

No. 2486. UNIONS: E. M. Dart Mfg. Co., 134 Thurber Ave., Providence, R. I. Catalog giving complete data on pipe unions and fittings with information on types, sizes, and prices. Dimension tables are given and the precision operations, materials, and methods of inspection used in the manufacture of these unions are described.

No. 2487. VALVES: Clark Cooper Co., 153 Jefferson St., Philadelphia, Pa. Data sheet on electrically operated valves for automatic or remote control of steam, water, oil, brine, "Freon," gas, air, etc.

No. 2488. VALVES: Walworth Co., 60 E. 42nd St., New York, N. Y. Issue of "Walworth Today", Vol. 1, No. 1, including a discussion of creep testing of metals, illustrating the steps in making a bronze valve, and other information. Vol. 1, No. 2, includes data on testing of metals at elevated temperatures, describes the new 350 lb union bonnet bronze valves, and illustrates the manufacture of a cast iron fitting.

No. 2489. VENTILATORS AND FILTER UNITS: Pacific Mfg. Corp., 4223 Lake St., Chicago, Ill. Circular describing the "Airvent" window ventilator and filter unit which circulates 300 cfm.

No. 2490. WATER VAPOR REFRIGERATION: Ingersoll-Rand Co., 11 Broadway, New York, N. Y. Bulletin on the application and advantages of steam jet water vapor refrigerating units, built in sizes from 10 tons upward, for operation at steam pressures as low as 2 lb. Examples of applications, rating curves, and details of construction and operation are given.

No. 2491. WELDERS: Hobart Bros., Canal Lock Sq., Troy, Ohio. Bulletin entitled "More For Your Money" featuring new selective motor hp control and the advantages of cutting current cost, improving power factor and reducing starting current.

No. 2492. WELDING FITTINGS: Bonney Forge & Tool Works, Tilghman & Meadow Sts., Allentown, Pa. 16 p. bulletin on "Weldolets" and "Thredolets," patented drop forged pipe fittings for making branch pipe connections by welding. The fittings and their design and construction are described, advantages are discussed and illustrated, and tables of stock sizes, dimensions, and weights are given.